THE SEA-MANS PRACTICE,

Containing

A FVNDAMENTALL PROBLEME in Navigation, experimentally verified:

Namely,

Touching the Compaſſe of the Earth and Sea, and the quantity of a Degree in our Engliſh meaſures.

ALSO,

An exact Method or forme of keeping a reckoning at Sea, in any kinde or manner of Sayling.

With certaine Tables and other Rules uſefull in Navigation. As alſo in the Plotting and Surveying of places.

The Latitude of the principall Places in ENGLAND.

The finding of Currents at Sea; and what allowance is to be given in reſpect of them.

By RICHARD NORWOOD, Reader of the *Mathematicks.*

LONDON,
Printed by T. FORCET for *George Hurlock*, and are be ſold at his Shop neere St. *Magnus* Church. 1644.

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SEAMANS PRACTICE,

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TO THE RIGHT HONble, ROBERT, Earle of WARWICK, Baron of LEES, &c.

Right Honourable:

ALthough the knowledge and practice of the Art of Navigation, be of late yeares growne to a farre greater Perfection than it can appeare to have had in any former Age: and by that meanes the World and all the Parts thereof have beene further discovered, yea Sayled round about: the traffick and entercourse of severall Nations how remote soever facilitated. Knowledge in divine and humane things divulged: and (which as I conceive is of most importance seeming as yet to be the principall scope of the divine Providence in discovering these Mysteries) the light of the glorious Gospell of CHRIST, being the mighty power of God unto salvation, is extended to those silly captives of Sathan in America, by meanes of those many Plantations wee have amongst them: which Plantations (even from their first breathing) have received no small furtherance from your Noble favour and bounty, as I know by my owne Experience in that where sometimes I was, and have understood no lesse by others in the rest.

Yet notwithſtanding this notable growth and daily exerciſe of the Art of Navigation, *it ſtill remaines imperfect in ſome points. For whereas the practice thereof, doth eſpecially conſiſt in the knowledge of the Latitudes, Courſes, and diſtances; the way of finding diſtances at ſea, namely by the Log and Line, is rather opinionative and conjecturall then certaine, being grounded upon this ſuppoſition, that the compaſſe of the world in any great Circle is* 21600 Italian *miles, (as they call them) and that ſuch an* Italian *mile containes* 1000 *Paces, and every of thoſe paces five* Engliſh *feete: and according to theſe meaſures they divide their Log-line, and keepe their account of the ſhips way at Sea.*

Having therfore by an experiment which I made a yeare ſince, found more neerely the compaſſe of the Earth, and the quantity of a Degree on the ſame in our knowne meaſures, and applyed it to uſe in Navigation, *in this Treatiſe following: and further added ſome other ſuch things as I conceived to be wanting in the practice of that Art: I have preſumed to preſent it to your Lordſhip, aſwell becauſe by your knowledge in* Navigation, *and the experience you have had in your Honorable enterpriſes at Sea, you are well able to judge of it: as alſo being confident that according to your noble diſpoſition you will favourably accept thereof, though otherwiſe of it ſelfe unworthy. The moſt High God, ever bleſſed and glorious, multiply unto your Honour all his bleſſings in* Chriſt Ieſus.

Your Honours in all
due obſervance,
Richard Norwood.

To

To the Reader.

THe circuit of the Earth and Sea (as the circumference of every Circle) containes 360 Degrees; by which degrees the Distances thereon are measured, so that the knowledge of the quantity of such a Degree in our knowne Measures is a fundamentall principle in Cosmography and Navigation, as upon which is grounded the reckoning of the Ships way or distance runne. For though a Mariner being in his voyage on the vast Ocean, have sometimes three things to certifie him where hee is, and how to shape his course to his desired Port, namely his Latitude, Course, and Distance, and sometimes a fourth; namely, some neare conjecture of his Longitude by the Variation or otherwise; yet oftentimes (as in close Weather) hee hath nothing but his Course and Distance; otherwhiles, onely his Latitude and Distance is his chiefe guide in falling with his intended Port. I know it is usuall to allow neere 7. Fathams or 41 $\frac{2}{3}$. feet to a Knot, and so many of those knots as runne out in halfe a Minute, so many Miles they account the Ships way to be in an houre. And if in halfe an minute she runne 41 $\frac{2}{3}$. feet, then in 60 Minutes or an houre shee runnes 5000 Feet, and thus they account 5000 English feet, or 1000 Paces to be a Mile, and 60 of those Miles to bee a Degree, such as the whole circumference in any great Circle is 360. But how is this knowne to be true? If it be answered, that it is knowne to be so by Experience, then I would know further by what experiment this was found to be so? Where, and by whom made? I presse this so much the rather, because I am perswaded wee have at this day as many excellent Navigators in this Kingdome, and as great Voyages performed as from any other place in the World, and I should be glad to heare of the experimentall resolution of this *Probleme* by some of them, though it were but in running eight or 10 Degrees neare the Meridian; for so I doubt not but that which I have here written thereof, would receive further Confirmation and better entertainment then haply it will now, being so much different from the Common opinion; and the Arts of Navigation and Cosmography would bee much more perfected in short time. For one Errour (as a fruitfull Mother) is oftentimes the cause of more, and so the removing of one the occasion of removing others; especially, when they doe mutually support one another: As wee shall here shew how the Errour in the Projection and use of the Common *Sea-chart*, is supported by this Errour of accounting onely 300000 of our Feet to a Degree; and this in like sort upheld by that, so that they will stand or fall together. And surely that had fallen long since being so manifestly convinced; if it had not beene upholden by this. For the confuting of that (I meane the Common *Sea-chart*) it was sufficient to know that the Earth and Sea make one Sphæricall body, but

in disproving and rectifying this, it is necessary to know moreover what is the quantity of that Sphericall body: and to that end it was necessary to make a sensible application of our knowne Measures, to a determined part of the whole; that so the quantity of that determined part being knowne, and the proportion thereof to the whole, the quantity of the whole might also bee discovered. And this I have endeavoured in the experiment following, which if I have not handled so exactly in all points as some would desire: That requiring more time and charge (then I could well bestow) yet I doubt not but it will bee found that I have come very neare the Truth. Some haply will censure me, for being my selfe at the Expence to make such an experiment. But I was as frugall in it as I could, adding paines and industry to save expence, I came up in tenne or eleven dayes, and had other necessary occasions to lead me from the one place to the other, and did this as a thing falling opportunely in my way. But indeed (as in all other parts of Learning) so in the *Mathematicks*, especially in their application, or middle Mathematicks (as some call them;) it is necessary with Speculation to joyne Actuall and Experimentall practises; the former being empty and uncertaine without these. It is true, that the Mathematicks afford large fields of delightfull Speculations, wherein a man might walke farre with much pleasure: But if from so many faire Flowers hee bring home no honey, or from such large fields no sheaves; I meane if hee bring not those Speculations to some usefull Practises; neither himselfe nor others are like to receive much fruit by them. But this indeed cannot be effected without more labour and difficulty, yea sometimes it requires Mechanicall and bodily exercises, which some esteeme too meane and unworthy to stoope unto. But for mine owne part, I acknowledge to have had my living and maintainance by the Mathematicks, and not by Speculation onely, but rather by my Practice therein; and therefore also I desire (what in me lyes) to make them fruitfull to my selfe and others: And to that end have spent in some principall parts of the Mathematicks, neare as much time and meanes in experimentall Practises and Conclusions, as in the Speculation. Moreover, considering that this particular Experiment was proposed above Thirty yeares since, by our Country-man Mr. *Edward Wright*, to invite some to the tryall of it, as a thing which hee would have done himselfe, if he had found such furtherance and opportunity as hee desired, which it seemes he did not, nor any other since that time: Rather then so noble and so necessary a *Problem* should longer rest unresolved, I tooke the opportunity offered, hoping it may bee an occasion to whet on some others to doe the like. This with some other things which I conceived to bee wanting in the Practice of Navigation, I have handled in this ensuing Treatise; which I commend to your friendly acceptance. Farewell.

July the first, 1636.

THE

THE SEA-MANS PRACTICE.

CHAP. I.

The Common opinion touching the compasse of the Earth, and quantity of a Degree of the same.

IT is a common received opinion in *England* (and the like is in other places) that allowing five of our *English* feet to a Geometricall pace, a thousand of those Paces make an *Italian* mile, and sixty of those Miles in any great Circle upon the Sphæricall surface of the Earth or Sea make a Degree; and thus it is supposed, that a Degree containes 60 Miles, or 60000 Paces, or 300000 of our *English* feet; and by such miles doe Mariners in their Voyages by Sea keepe their reckonings: And because the whole circumference of a Circle is 360 Degrees; therefore the compasse of the Earth according to this opinion should be 21600, such *Italian* miles, or 21600000 Paces, or 108000000 of our *English* feet. Whence this opinion came, or upon what experiment it should be grounded, I cannot certain-

certainly say; It may seeme to be taken or rather mistaken from *Ptolomey*, who saith, there are 500 *Stadiums* in a Degree, the same was before affirmed by *Marinus Tyrius*, of whom *Ptolomey* speaking in the 11. Chapter of his first Booke of *Geography* hath these words, *Sed in hoc quoq; recte sentit partem unam qualium est circulus maximus Tricentorum sexaginta, quinginta in terra constituere Stadia, id enim confessis dimensionibus consonum existit.* Now a *Stadium* not onely amongst the *Greekes*, but as appeares by *Herodotus*, amongst all other Nations of *Asia* and in *Egypt*, did consist of 600 Feet or 100 *Orgyas*, an *Orgya* conteyning six feet or foure Cubits as our fatham doth; the same is also testified by *Suidas* and others: So that a Degree containing 500 Stadiums, and every Stadium 600 Feet, it followes that a Degree must containe 300000 feet, exactly agreeing in number with the common received opinion in England, which therefore may seeme to be hence derived, and would also receive much confirmation hereby, (hee being an Author of such approved credit) if it could be approved that our *English* feet were exactly equall to the *Egyptian* or *Alexandrian* foot, where *Ptolomey* wrote. Otherwise that being true that so many of their feete make a degree, it will follow that if ours be greater, there be fewer of them contained in a degree; if lesser (as undoubtedly they are) there must be more of them contained in a Degree.

Philander in his Commentary upon the third Chapter of the third booke of *Vitruvius*, hath expressed the quantity of the ancient *Romane* foot, where (by a competent allowance for the shrinking of the paper being printed wet) it may probably be gathered that it was somthing longer then our English foot. But the *Alexandrian* and *Egyptian* foot was much greater, for according to *Heronis chanicus*, five *Alexandrian* feete were equall to six *Romane* feete: seeing then the ancient *Romane* foot was something greater then ours, the *Alexandrian* foot must needs be much greater then ours. So that whereas *Ptolomey* saith there are 500 *Stadiums* in a degree, and as we have shewed a *Stadium* did consist of 600 feete, these being *Egyptian* or *Alexandrian* feete as it is most probable, being the place where *Ptolomey* lived; there must be a farre greater number of our feete in a *Stadium*, and so in a degree, whence

it

it is evident that there is no sufficient footing for this common opinion in the assertion of *Ptolomey*.

Neither doth the Practice and experience of Mariners in their Voyages at Sea prove it; for there is no reckoning or experiment at Sea set downe by any (that I have seene) to confirme it. And though it be true, that in saying between two places that lye neare to one and the same Parallel, they ground their reckoning chiefly upon this supposition, that 300000. of our English feet make a Degree, yet can they seldome or never by those reckonings discerne the Errour, the rather for that they have beene, and for the most part are still kept upon the Plane or Common *Sea-chart*, which makes a Degree in any Parallel equall to a degree in the Equinoctiall; and so makes a Degree in any Parallel to containe 300000 feet: And it is true, that in some Parallel a Degree doth containe onely 300000. of our English feet; namely, about that Parallel which is in Latitude 35 degrees (as wee shall further shew hereafter) neare unto which have the principall of our Easterne and Westerne voyages beene made. And thus though this opinion of 300000 feet in a Degree, and the projection of the *Common Chart* bee both erronious; yet because the errour of the one doth something salve the other, they could not bee so easily discerned by Experience onely.

This opinion of 300000 *English* feet to a Degree, may seeme also to be something confirmed by an Observation made by our Countrey-man Mr. EDVVARD WRIGHT, upon Mount *Edgecombe* neere *Plimouth*, of the Semidiameter of the Earth which hee hath set downe in his Booke, *Of the Correction of Errours in Navigation*, Chapter 15. Where he findes the *Semidiameter* to bee 18312621 of our English feet, whence it may be gathered, that in a degree of a great Circle of the Earth, there should not be full out 300000 of our feet; but the way by him then used, though it was very fit for the end whereunto hee there applies it, namely to finde the dipping or depression of the apparent Horizon beneath the true, according to the height of the eye above the Water; yet will it easily be granted to be

no exact way for finding the *Semidiameter*, and consequently the Circumference of the Earth, or the quantity of a Degree on the same; and so doe sayes there, that he used that way, because hee wanted opportunity to put in practice a more exact way. Wherefore for the further satisfaction of my selfe and others in this Point, and chiefly for the necessary use it hath in the Practice of *Navigation*, I have made the Experiment following, that so the quantity of a Degree, and of the whole Compasse of the Earth might at least-wise be nearely knowne in our English measures.

CHAP. II.

An Experiment made for finding the quantitie of a Degree, and so the Circumference of the Earth and Sea in our knowne measures.

HAving occasion to bee in the City of *Yorke*, about the beginning of *Iune*, *Anno* 1635. I made there severall Observations of the Meridian Altitude of the Sunne, the last of which was made the Eleventh day of *Iune*; the Sky was every of those dayes something over-cast at Noone, yet not so much but that an observation might bee made to a neare scantling: And because the last of these Observations is most fit for the present occasion, and that day was as cleere as any of the other, we will here especially make use of that, being as followeth.

Upon the Eleventh of *Iune* 1635. I made an observation neare the middle of the City of *Yorke*, of the Meridian Altitude of the Sunne, by an Arch of a *Sextant* of more then five foote Semidiameter, and found the apparent Altitude of the Sunne that day at Noone, to be 59 Degrees 33 minutes.

I had also formerly upon the eleventh day of *Iune*, *Anno* 1633. observed in the City of *London*, neare the *Tower*, the appa-

apparent Meridian Altitude of the Sunne, and found the same to be 62 Deg. 1 min.

And seeing the Sunnes declination upon the eleventh day of *Iune* 1635, and upon the eleventh of *Iune* 1633, was one and the same without any sensible Difference; and because these Altitudes differ but little, wee shall not need to make any alteration or allowance, in respect of Declination, Refraction, or Parallax: Wherefore subtracting the lesser apparent Altitude; namely, 59 Degrees 33 minutes, from the greater 62 degrees 1 minute, there remaines 2 degrees 28 minutes, which is the difference of Latitude of these two Cities, namely of *London* and *Yorke*.

Also, by the foresayd Observation made in *Yorke*, it appeares, that the Latitude of that City is 53 degrees 58 minutes almost.

But to our purpose, comming at that time from thence to *London*, I further found by measure, that the Parallel of *Yorke* is from the Parallel of *London* 9149 Chaynes, every chayne being sixe Poles, and every pole 16½ of our English Feet; that is, every Chayne ninety nine Feet. (After what manner I found this to be so, wee shall further expresse hereafter.) But thus as I say, I found that *Yorke* is more Northerly then *London* by 9149 Chaynes; And before, we have noted that these two places differ in Latitude 2 degrees 28 minutes; therefore it followes, that 2 deg. 28 minutes of the Meridian on the Earth and Sea, is equall to 9149 Chaynes. And if accordingly we would know how many of these chaynes are contayned in one Degree, we may find that, by the Rule of Proportion, first reducing the Degrees into Minutes, and then say,

If the difference of Latitude	148 co. ar.	7,	82974
give such a number of Chaynes,	9149	3	96137
Then one Degree, that is	60	1	77815
gives of such Chaynes	3709	3	56926

and some what more, namely five Feet, which reduced into feet, make 367196, that is 367200 Feet in a Degree lacking 4 feet, which here we regard not.

 Thus

Thus then according to this Experiment, it is evident that one degree of a great Circle measured on the Earth is neare 367200 feet, which in our Poles of 16½ feet, is 22254 poles and about one halfe, and these reduced into Furlongs at 40 poles to the Furlong, make 556 Furlongs and 14 Poles; and lastly, these reduced into our English miles, of 8 Furlongs to a mile, make 69 Miles, and 4 Furlongs, 14 Poles, that is 69½ Miles and 14 poles to a Degree.

And hence according to the most approved *Hypothesis* of the *Sphericity* of this *Terrestriall Globe*, wee may find the Compasse of it as followeth. But first, you may note that we speake not here of the compasse of the Earth in any Parallel or lesser Circle described upon any side thereof, (that being various according to the different distance of those Circles from their Poles) but of the Compasse taken in the middle or greatest thicknesse of the Globe, namely in any great Circle, such as divide the whole Globe into two equall parts, of which kind are the Equinoctiall and all Meridians &c. this being properly the *Perimeter*, or Compasse of a *Spheriecall Body*.

Now seeing a Degree is the 360 part of the circumference of a Circle (for any circumference being divided actually or by supposition into 360 equall parts, those parts are called Degrees) if wee can find how many Feet, Paces, Miles, or other knowne measures are contained in one of those Degrees, then shall wee easily conclude how many of the same knowne measures are contained in the whole Circumference: But by the former Experiment we find, that in one degree of a great Circle on the Spharicall Superficies of the earth, there is contained 367200 Feet; therefore it is evident, that 360 times 367200 feet, is the Compasse of the whole; wherefore multiplying 367200 by 360, the Product is 132192000 feet, which reduced into Poles is 8011636, and these reduced into Furlongs, are 200290 Furlongs 36 Poles; and lastly, these reduced into Miles are 25036 English miles and somewhat more, for the circuit of the Earth and Sea.

If further we desire the Diameter and Semidiameter of the

Earth,

Earth, forasmuch as it is proved by *Archimides*, that the proportion of the circumference of a Circle is to the Diameter thereof, almost as 22 to 7; Therefore by the Rule of Proportion, as 22 to 7, so is the Circumference of the Earth to the Diameter thereof, so that multiplying the Circumference of the Earth, namely 132192000 Feet by 7, and dividing the Product, namely 925344000 by 22 the Quotient, namely 42061091 is the Diameter of the Earth in Feet, the halfe whereof, namely 21030545 Feet, is the Semidiameter of the same being 21 millions of Feet and somewhat more: these reduced into English miles as before we did the Circumference, shew the Diameter of the Earth to be 7966 Miles and somewhat more, and the Semidiameter 3983. And thus we have the Circumference, Diameter, and Semidiameter of the Earth, as also the quantity of a Degree of the same Circumference in knowne measures of Feet, Furlongs, and Miles, &c. There are onely two things heere which may seeme doubtfull; namely, the Experiment it selfe, and the *Hypothesis* of the Sphæricity of this *Terrestiall Globe* consisting of the Earth and Sea, for these being admitted, the measures thence deduced as before, will necessarily follow.

Now touching the Experiment, I confesse that to have made it so exactly as were requisite and in all points so as I shall shew in the Chapter following, would have required much more time and expence, then mine ability would reach unto; Yet having made Observation at *Yorke* as aforesaid, I measured (for the most part) the Way from thence to *London*, and where I measured not, I paced; (wherein through custome I usually come very neare the truth) observing all the way as I came, with a Circumferentor, all the principall Angles of position or windings of the way (with convenient allowance for other lesser Windings, Ascents, and Descents) and these I layd not downe by a Protractor after the usuall manner, but framed a Table much more exact and fit for this purpose, as wee shall after shew; so that I may affirme the Experiment to bee neare the truth.

Touching the *Hipotheſis* that the Earth and Sea make one Spherical or round body, it is generally agreed upon by all the Philoſophers, Aſtronomers, Geographers, and Navigators, ancient and moderne, ſome reaſons demonſtrative for the confirmation thereof may be theſe.

Firſt, the Eclipſes eſpecially of the Moone, which are cauſed by the ſhadow of the body of the Earth being interpoſed betweene the Sunne and the Moone, and for aſmuch as this ſhadow doth fall upon the Moone, alwayes and on every ſide circular, and ſo appeares to us, it is manifeſt by the Opticks, that the Earth from whence it proceeds is a Spherical body.

Secondly, likewiſe the Eclipſes of the Sunne which are cauſed by the interpoſition of the Moone betweene the Sunne and thoſe places where it appeares Eclipſed; I ſay it could not bee determined when and in what place ſuch an Eclipſe ſhould appeare, and where not, if the forme of the Earth were not knowne; but ſeeing the places where ſuch Eclipſes happen, and where not, may be and are uſually determined, and that upon this ground; that the Surface of the Earth is Spherical, it is thence alſo ratified to be a truth.

Thirdly, the Sunne, Moone, and Starres, doe riſe and ſet, and are upon the Meridian ſooner to thoſe that are reſident in the Eaſterne parts, then to others more Weſterly, and that in a proportion anſwerable to the rourdneſſe of the Earth, as the Planets and Starres are upon our Meridian at *London* ſooner by almoſt foure houres, then they are to thoſe that inhabit *Summer-Ilands*, and the confines of *Virginia*, and *New-England*; And ſo in *Eaſt-India*, and other Eaſterne Regions, the Sunne and Starres are ſooner upon their Meridian then upon ours, which is manifeſt to be ſo, as by other reaſons, ſo eſpecially by the Eclipſes of the Moone; for an Eclipſe of the Moone hath not in it ſelfe any diverſity of time, being at one and the ſame inſtant without reſpect of places; yet becauſe in the Eaſterne parts the day is begun and it may be farre ſpent before it begin in places far Weſterly, therefore ſuch an Eclipſe may appeare to the Eaſterne inhabitants towards the end of their night, which to the Weſterne appeares

peates in the beginning or middle of the ſame night with them, and ſo the difference will be more or leſſe, according to the different diſtance of thoſe places in Longitude.

Fourthly, furthermore we ſee, that going or ſayling to the Northwards; we have the Articke Pole and Northerne Starres more elevated, and the Antartieke Pole and Southerne Starres more depreſſed; the Elevation Northerly increaſing equally, with the depreſſion Southerly, and either of them proportionall to the diſtances which we goe, the like happeneth in going to the Southwards. Beſides the obliqne Aſcentions, Deſcentions, Occultations, Emerſions, and amplitudes of riſing and ſetting of the Sunne and Starres, in every ſeverall Latitude agreeable to the *Hipotheſis* of the Earths Sphericity. All which could not be ſo, if the Earth were of any other then of a Spherieall forme.

Fiftly, ſo if we ſtand upon the Sea-ſhore, and ſee a Ship farre off under ſayle making towards the Land, at firſt we ſee onely the top-Sayles or higheſt parts, and withall doe manifeſtly behold the convex Superficies of the Sea, as it were raiſed and interpoſing it ſelfe betweene our ſight and the Hull or lower parts of the Ship till ſhe approacheth neerer, and this uniformely, every wayes alike, and proportionably to the ſeverall diſtances which evidently demonſtrate the Spherieall roundneſſe thereof.

6 And laſtly (to adde no more) the Navigations of theſe latter times make it apparent, thoſe eſpecially that have beene made round about the World, as thoſe two Voyages by our famous Countrey men Sir *Francis Drake*, and Mr. *Thomas Candiſh*, both which ſeverally ſayling from our Coaſts to the *Weſt-Indyes*, and paſſing the Streights of *Magellane*, continued their courſe Weſterly till they came into thoſe parts which are from us to the Eaſtwards; namely, to the *Eaſt-Indyes*, and ſo ſayled ſtill Weſterly till they came to *Cape bon Eſperance*, and thence returned into *England*, having ſayled about the whole terreſtiall-Globe, they found nothing by their Obſervations or reckonings diſſonant from the uniforme-*Sphericity* thereof

in

in all its parts, That they came short in the number of dayes, one, and reckoned the time of their absence lesse by one day and a night then they which remained at home, this further confirmes the thing in hand.

Yet whilst we speake here of the Roundnesse of the Earth and Sea, we intend it not so strictly as if it were a thing turned round without any inequality in its Superficies; But as a Bowle or Ball, though it have some dust or small graines of sand cleaving thereto may still be said to be round; So though the Land, Hils, and Mountaines, be somewhat raised above the Spherical Superficies of the Sea, and if there should be also some Valleyes or bottomes more depressed; yet seeing the greatest of these inequalities have scarce any sensible proportion to the whole, wee may well affirme the whole to be round.

The relations made of the prodigious height of some Mountaines, as to bee 60, or 70 Miles high, if it be understood of their perpendicular or direct height are fabulous; The Mount *Atlas* recorded by some of the Ancients, to reach up almost to the Moone, and to bee as it were a Pillar for the Heavens to rest upon, being measured Geometrically by *Eratosthenes*, the perpendicular or upright height from the top thereof to the Valleyes beneath, was found not to exceed tenne *Stadiums*, which of our English measures is little more then a Mile and a quarter, a *Stadium* not much differing from our Furlong, and the like might be shewed of others.

But if we admit the highest Mountaines to rise perpendicularly above the Sphærical-Superficies of the Sea two miles, yet seeing the Diameter or whole thicknesse of the Earth, is as we have before-shewed 7966 Miles, this exorbitancy or difference of two Miles is of small moment; yea, if there were any Mountaine eight miles in height upright, yet this compared with the whole thicknesse of the Earth, is little more then one thousand part thereof; therefore wee may conclude, that this *Terrestriall Globe*, consisting of the Earth and Sea is *Sphærical*. We come in the next place to shew by what way of measuring wee found the Parallel of *Yorke* to bee distant from the Parallel of *London*

9149 Chaynes. And so how the distance of the Parallels of two Places may be exactly measured.

CHAP. III.

A most exact way for finding the quantity of the Diameter and Circumference of the Earth and Sea, and of a Degree on the same.

I Doe the more fully set downe the way of making this Experiment, that so I may give occasion to any who are so nobly minded for a publique good, as to be at that charge to make a further and more exact tryall thereof. Now then, the best and perfectest way is, to observe so exactly as may be the Summer *Solstiall-Altitudes* of the Sunne at two places, so farre distant asunder and lying so neare North and South each from other, with so direct and faire a way betweene them as conveniently may be chosen; Suppose for example *Christ-Church* and *Berwick*, or some other place in the furthest parts of *Scotland*, for the further these two places are each from other, the more perfectly may this businesse be performed. Then measure as truely as is possible and set downe in a booke, all the way betweene those two places, with all the Windings, Ascents, and Descents that are therein, whereby with helpe of the ensuing Table you may easily and exactly find how much the one place is more Southerly then the other. For this purpose the *Plane Table* is not the fittest instrument, but rather a *Theodolite* or *Peraton*, or some other of that kind, observing diligently the Variation of the Needle. The Chayne may be six Poles long, or rather 100 Feet, and the Table fitted accordingly. (but the Table following is for Poles) if it should be much longer it would be too heavie.

The High-wayes are commonly crooked, yet because of sundry Obstacles and Impediments which are incident out of the way, and because a man cannot certainly at first direct himselfe the neerest and best way to the place intended, it would bee expedient

pedient to measure the distance as aforesaid; First, in the High-wayes leading from the one to the other, and then in the neerest and best way that could be chosen betweene them, and so if any notable Errour happen in the one, it may be discovered and amended in the other. The forme which I observed in setting downe the Measures and Angles, was according to this Example.

Deg.	*Distance.*	*North.*	*South.*	*East.*	*West.*
S E. 31					
S E. 20					
S E. 15					
S E. 13					
S W. 22					
S E. 05					

It is to be understood, that the Table here following was before calculated to serve in stead of a *Protractor*, for a Circumferentor or other Ordinary Instrument, and for a chayne of three Poles, which for the most part I use; yet it may very well be applyed to a chayne of six Poles (as in this businesse it was) reckoning every chayne to be two, &c. And thus for every tenne chaynes of six Poles, to a chayne I make two strokes signifying two Chaynes or 20 Chaynes, and if there be any odde Chaynes, for those I set a Figure in another line next below, and if moreover any odde Poles, whether one or two, for those I set another figure in a third line below.

Thus the last entrance before going, being *S E.* 05 Degrees, [illegible] signifies that the Line upon which I went, was from the South-part of the Meridian to the Eastwards, making

king an Angle with the Meridian of 5 Degrees, the nine strokes signifie nine Changes or ninety Chaynes, the Figure 5, signifies five Chaynes, and the figure 2, two Poles. So that it is to bee read thus; South Easterly 5 Degrees, 9 Changes, 5 Chaynes, and 2 Poles; and the like is to be understood of the rest, But for the most part having liberty of ground, I end the measure of every line, either with a whole number of changes, or at least of chaynes.

And thus proceeding all day, towards the Evening or when else, I have time convenient, I reduce all these Distances upon what Lines or Angles soever they be, to Distances of *North* or *South*, *East* or *West*, as here appeares;

Deg.	*Distance.*	*North.*	*South.*	*East.*	*West.*
			2571	1545	
S.E. 31	9				
			2819	1026	
S.E. 20			1692	616	
	6		0169	062	
S.E. 13			2923	675	
S.E. 13					
	0		1754	404	
S.W. 02			1499		052
	0		2690	235	
S.E. 05			0149	013	
	2		0020	002	
Chaynes.	571		16286	4578	052
	2		9	52	
Poles.	1715		16286	4526	

We will explaine the last, and so the rest may easily be understood: *S.E.* 5 deg. 5. 2. here because I have *S.E.* the numbers taken out of the Table must be put into the Columes entituled *South* and *East*. Then in the Table under 5 deg. I looke for 9 Changes, and find against it 2690. and in the adjacent Col. under the Compl. thereof 235, and because *S.E.* 5 deg. is lesse then 45. deg. that is nearer to the South then to the E. I put in the Col. entituled *South* 2690, and in that entituled *East* 235; then againe

in

in the ſame Tabular Columne under 5 degrees, I finde againſt 5 Chaynes (cutting off a Figure, becauſe 5 Chaynes is but the tenth part of 50 Chaynes) 149 to bee put in the *South* Columne, and 13 for the *East* Columne.

Laſtly, againſt 2 Poles, I finde for the *South* Columne 20, and for the *Eaſt*, and the like is to be underſtood of all the reſt.

Now ſuppoſing this laſt to bee a place whoſe Diſtance and Scituation from the firſt is required, I ſum up the Columnes ſeverally, and of the *North* and *South* Columnes, ſubtract the leſſer from the greater, and ſo of the *Eaſt* and *Weſt* Columnes, and ſo it will appeare how much *North* or *South*, and how much *Eaſt* or *Weſt* the laſt place is from the firſt.

As in this Example, wee find the laſt place to be to the Southwards of the firſt 1628 Poles, for the laſt figure may bee cut off, being uſed in the Table, onely for the more exactneſſe, or may be made a Fraction, and ſo it is 1628 $\frac{1}{10}$ Poles; Likewiſe the laſt place is to the Eaſtwards of the firſt 450 $\frac{5}{10}$ Poles, and thus I proceed all the way.

Now touching the Angles of aſcent and deſcent of Hills and Valleyes, to have obſerved them exactly, would have required more time and charge then I could of my ſelfe beſtow; yet I made allowance for ſuch of them as were of moſt moment, hee that would obſerve them all, may either make two or three Columnes more, or keepe an account of them apart by themſelves. But if hee intend no further uſe of them but to find the neareſt Diſtance, he need not ſet them downe, but make allowance for them on the ground, keeping his diſtances intire without Fractions.

As admit, I obſerve the Aſcent from a Valley to the brow of a Hill, to bee 14 degrees above the Levell or Horizontall Line, and that meaſuring, I find the diſtance to bee 30 Poles; I turne to the Table, and under 14 degrees and againſt 30 Chaynes I find 1911, and 720, ſhewing that the Levell or Horizontall diſtance from my Station to that brow is onely 29 $\frac{11}{10}$ Poles, and that the height of that brow above the levell Line, is 7 $\frac{20}{10}$ Poles. But finding thus that the *Hypothenuſall* being 30, the

Baſe

Base or *levell Line* is but 29 $\frac{11}{12}$, that is lesse by $\frac{1}{12}$, because J would avoyd this Fraction, I adde to the end of the foresaid measure of 30 Poles upon a levell Line $\frac{1}{12}$ of a Pole, and then I may account my selfe distant from the place in the Valley where J made Observation 30 Poles in a *Levell* or *Horizontall line*, and so set downe the Distance without a Fraction, the like is to bee understood of all other Ascents and Descents.

Here followeth the Table.

	1. deg	89. d.	2. deg	88. d.	3. deg	87. d.	4. deg	86. d.	5. deg	85. d.
1	300	5	300	10	300	15	299	21	299	26
2	600	10	600	21	600	31	599	42	598	52
3	900	15	900	31	899	46	898	63	896	79
4	1200	20	1200	42	1198	62	1198	84	1195	105
5	1500	26	1500	53	1497	78	1497	105	1494	131
6	1800	31	1799	64	1798	93	1796	126	1794	157
7	2100	37	2099	74	2097	110	2095	147	2093	183
8	2400	42	2398	84	2397	124	2394	168	2391	209
9	2700	47	2698	95	2696	140	2694	189	2690	235
10	3000	52	2998	105	2996	157	2993	210	2989	262
1	10	0	10	0	10	0	10	1	10	1
2	20	0	20	1	20	1	20	1	20	2

	6.deg	84.d.	7.deg	83.d.	8.deg	82.d.	9.deg	81.d.	10.d.	80.d.
1	298	31	298	37	297	42	296	47	295	52
2	597	62	596	74	594	84	592	94	590	104
3	895	94	894	111	891	125	889	140	887	156
4	1193	126	1192	146	1188	167	1185	187	1182	208
5	1492	157	1489	183	1485	209	1481	234	1477	260
6	1790	188	1787	220	1782	251	1777	281	1772	312
7	2089	220	2085	257	2080	292	2074	328	2069	365
8	2386	251	2383	292	2377	334	2371	375	2364	417
9	2686	283	2680	329	2674	376	2667	422	2659	469
10	2984	314	2978	366	2971	418	2963	469	2954	521
1	10	1	10	1	10	1	10	1	10	1
2	20	2	20	2	20	3	20	3	20	3

	11.d.	79.d.	12.d.	78.d.	13.d.	77.d.	14.d.	76.d.	15.d.	75.d.
1	295	57	293	62	292	67	291	73	290	78
2	580	114	586	142	584	134	582	146	580	156
3	893	172	881	188	876	203	873	219	870	233
4	1178	229	1174	250	1169	270	1164	292	1160	310
5	1473	286	1467	312	1461	337	1455	363	1449	388
6	1768	343	1760	374	1754	404	1746	436	1739	466
7	2060	401	2055	436	2047	472	2038	508	2030	543
8	2355	458	2348	500	2339	540	2329	580	2320	621
9	2650	515	2641	562	2631	608	2620	653	2610	699
10	2945	572	2934	624	2929	675	2911	726	2898	776
1	10	2	10	2	10	2	10	2	10	3
2	19	4	19	4	19	4	19	4	19	5

	16.d.	74.d.	17.d	73.d.	18.d.	72.d.	19.d.	71.d.	20.d.	70.d.
1	288	83	287	88	285	93	284	98	282	103
2	576	166	574	177	570	186	568	196	564	206
3	865	250	861	264	855	279	851	294	846	308
4	1153	332	1148	352	1140	371	1135	391	1128	411
5	1442	413	1434	438	1426	463	1418	488	1419	513
6	1730	496	1721	526	1711	556	1702	586	1691	616
7	2019	580	2008	615	1997	649	1986	684	1973	719
8	2307	663	2296	703	2282	743	2270	782	2255	822
9	2596	746	2583	791	2567	836	2552	880	2537	924
10	2884	829	2869	877	2853	927	2836	977	2819	1026
1	10	3	10	3	10	3	10	3	10	3
2	20	5	19	6	19	6	19	6	19	6

	21.d.	69.d.	22.d.	68.d.	23.d.	67.d.	24.d.	66.d.	25.d.	65.d.
1	280	107	278	112	276	117	274	122	272	127
2	560	215	556	224	552	234	548	244	544	254
3	840	322	834	337	828	351	822	366	816	381
4	1120	429	1112	449	1104	468	1096	488	1088	508
5	1400	537	1391	562	1380	586	1370	610	1360	634
6	1680	645	1669	674	1656	703	1644	723	1632	761
7	1960	752	1947	786	1932	820	1918	854	1904	888
8	2240	860	2225	899	2209	937	2192	976	2175	1015
9	2521	968	2504	1011	2485	1054	2466	1098	2447	1142
10	2801	1075	2782	1124	2761	1172	2740	1220	2719	1268
1	9	4	9	4	9	4	9	4	9	4
2	18	7	18	8	18	8	18	8	18	8

	26.d.	64.d.	27.d	63.d.	28.d.	62.d.	29.d.	61.d.	30.d.	60.d.
1	270	131	267	136	265	141	262	145	260	150
2	540	263	534	272	530	282	524	290	520	300
3	810	394	801	408	795	423	786	435	780	450
4	1079	525	1068	544	1060	564	1048	581	1040	600
5	1348	657	1336	681	1324	704	1312	727	1299	750
6	1618	788	1603	817	1589	845	1574	872	1559	900
7	1888	919	1870	953	1855	986	1836	1017	1819	1050
8	2157	1050	2138	1089	2120	1127	2098	1162	2079	1200
9	2427	1182	2405	1225	2384	1267	2361	1308	2339	1350
10	2696	1315	2673	1362	2649	1408	2624	1454	2598	1500
1	9	4	9	5	9	5	9	5	9	5
2	18	8	18	10	18	10	18	10	18	10

	31.d.	59.d.	32.d.	58.d	33.d.	57.d.	34.d.	56.d.	35.d.	55.d.
1	257	154	254	159	252	163	249	168	246	172
2	514	309	508	318	504	326	498	336	492	344
3	773	463	763	477	755	489	747	504	738	516
4	1028	617	1017	636	1007	653	995	671	983	688
5	1285	772	1272	795	1258	817	1243	838	1228	860
6	1542	927	1526	955	1510	980	1492	1006	1474	1032
7	1809	1081	1780	1113	1762	1143	1741	1174	1720	1204
8	2057	1235	2034	1272	2013	1307	1990	1342	1966	1377
9	2314	1390	2288	1431	2265	1470	2238	1510	2212	1549
10	2571	1545	2544	1590	2516	1634	2487	1677	2457	1721
1	9	5	8	5	8	5	8	6	8	6
2	18	10	16	10	16	10	16	12	16	12

	36.d.	54.d.	37.d.	53.d.	38.d.	52.d.	39.d.	51.d.	40.d.	50.d.
1	243	176	240	180	236	185	233	189	230	193
2	486	352	480	360	472	370	466	378	460	386
3	729	528	720	541	709	555	699	567	690	578
4	971	705	960	721	945	739	931	756	919	771
5	1213	881	1198	902	1182	923	1165	944	1149	964
6	1456	1057	1438	1082	1418	1108	1398	1133	1379	1157
7	1699	1234	1678	1262	1654	1293	1631	1322	1609	1350
8	1942	1410	1918	1443	1890	1479	1865	1511	1839	1543
9	2185	1586	2157	1624	2126	1663	2098	1700	2069	1735
10	2427	1763	2396	1805	2364	1847	2331	1888	2298	1928
1	8	6	8	6	8	6	8	6	8	6
2	16	12	16	13	16	12	16	12	16	12

	41.d.	49.d.	42.d.	48.d.	43.d.	47.d.	44.d.	46.d.	45.d.	45.d.
1	226	197	223	201	219	205	216	208	213	212
2	452	394	446	402	438	410	432	416	424	424
3	678	591	669	603	658	614	648	625	636	636
4	905	788	892	803	878	819	864	833	849	849
5	1132	984	1114	1003	1097	1023	1079	1042	1061	1061
6	1358	1181	1337	1204	1316	1228	1295	1250	1273	1273
7	1584	1378	1560	1406	1535	1433	1511	1458	1485	1485
8	1810	1575	1783	1606	1754	1638	1727	1666	1697	1697
9	2036	1772	2006	1807	1974	1842	1943	1874	1910	1910
10	2264	1968	2229	2007	2194	2046	2158	2084	2122	2122
1	8	7	7	7	7	7	7	7	7	7
2	16	14	14	14	14	14	14	14	14	14

The Structure of this Table is from this ground:

As *Radius* is in proportion to the Distance of two places measured in their Rumbe, so is the Sine of the Complement of that Rumbe to the difference in Latitude of these two places.

And so is the sine of that Rumbe, to the distance of the Meridians of those two Places. As admit I measure South-Easterly 20 degrees 300 Poles; here then the Rumbe upon which I measure, making with the Meridian an Angle of 20 degrees, I say,

As *Radius* is in proportion		
to the distance measured 300 Poles;	——	2, 47712
So is the sine Complement the Rumbe, S E. 20 deg.		9, 97299
to the difference of Latitude 281 $\frac{21}{100}$ *fere*	——	2, 45011

Whereby it appeares, that the distance of the Parallels of these two places is 281 $\frac{21}{100}$ Poles; or that the place whereto I measure, is more Southerly then the place from which I measured, by 281 $\frac{21}{100}$ Poles. Now for the distance of their Meridians, say

As *Radius* is in proportion		
to the distance measured 300 Poles;	——	2, 47712
So is the sine of the Rumbe S E. 20 deg.	——	9, 53405
to their distance in Longitude 102 $\frac{21}{100}$	——	2, 01117

And thus I find the place whereto I measured is more Easterly then the place from which I measured by 102 $\frac{21}{100}$ Poles, and somewhat more. And in like sort may be found all the other numbers expressed in this Table, but having thus found for every degree to 45 degrees two numbers, the rest may be deduced from these as in this example, 300 Poles at three Poles to the Chayne, is two Chaynes or tenne Changes, finding that in tenne Changes upon this degree, the difference Southerly is 281 $\frac{21}{100}$ Poles, it must be for five Changes which is just halfe so much

Ch	*Poles.*
1	28.19
2	56.38
3	84.55
4	112.76
5	140.85
6	169.14
7	197.38
8	225.52
9	253.71
10	281.92

be

bee almost 141, and for one Change which is a tenth part 28 $\frac{2}{10}$ *fere*, and so for two Changes twice so much, that is, 56 $\frac{4}{10}$; for three Changes thrice so much, that is the summe of the two former, namely 84 $\frac{6}{10}$, and so by addition only you may find the rest, as in this Table, which I shall need to prosecute no further. And thus you may make it to the hundreth or thousand parts of a Pole, but this for ordinary occasions, for which it was at first intended may suffice.

And according to this Example, it will be easie to frame the like Table for a Chayne of any other size, or for any other measure which you use.

It may bee objected, that howsoever this Rule holds true in Plaine-Triangles, yet the Triangles heere used are neither Plaine nor Spherical; for a Plaine-Triangle is made of three right Lines, and a Spherical of three Arches of great Circles, but in this the three sides are of three severall kinds, namely, one side is an Arch of the Meridian, and so of a great Circle, another an Arch of a Parallel, and so of a lesser Circle, the third side or *Hypothenusall* being the Rumbe, is no Arch of a Circle, but a Segment of an *Helispherical* Line.

But I answer, that notwithstanding this may bee Speculatively conceived, and so demonstrated to bee no Plaine-Triangle, yet in so small Distances as these which heere we use, there can be no sensible nor scarce any numerable difference. Yea the distance betweene two Parallels by the Rumbe and distance given (being the thing heere chiefly aymed at) is very exactly found by this Rule, as before we have shewed, and as is more fully demonstrated by Mr. *Wright*, in the 12 Chapter of his Booke, *Of the Correction of Errours in Navigation*: Whence we may conclude, that the parts of the Meridian collected by this Table according to the Rumbes and Distances, as wee have before shewed, doe give the true measure of the Segment of that Meridian intercepted, betweene the Parallels of the two Places proposed.

CHAP. IIII.

Of the difference of Longitude, Position and Distance of Yorke *and* London; *And how the Maps of* England *may by this Experiment be reformed, especially in the Latitudes of Places.*

WEe come next to speake of the Easterly and Westerly distances gathered as before is shewed by these Tables, and to find thereby the difference of Longitude, and of this wee will give an Example in the foresaid Experiment: whereby we find that the distance in Longitude, or the East and West distance betweene *Yorke* and *London* is neere 14000 Poles, *London* being so much more Easterly then *Yorke*. And before wee have found that in a degree of the Meridian, and consequently in a Degree of the Equinoctiall there, is neere 3709 $\frac{1}{2}$ Chaynes, at sixe Poles to the chayne; and this 14000 Poles converted into such Chaynes is 2333 $\frac{1}{3}$.

Which 2333 $\frac{1}{3}$ Chaynes (for finding the difference of Longitude) are not to be reckoned in the Parallel of *Yorke*, that being too much Northerly, neither in the Parallel of *London* being too much Southerly, but in a middle Parallel betweene both, namely, about the Latitude of 52 degrees 45 minutes. Now to find what difference of Longitude is answerable to this 2333 $\frac{1}{3}$ chaynes in the Parallel of 52 degrees 45 minutes, say

As Radius is in proportion

to sine Complement the Latitude *S C.* 52 deg. 45 min.	9,78197
So is the measure of a deg. in the Equinoctiall 3709 $\frac{1}{2}$.	3,56927
to the measure of a deg. in that Parallel 2245 $\frac{1}{12}$ =	3,35124

And

And thus we find that in the Parallel whose Latitude is 52 degees 45 minutes, there are 2245 $\frac{1}{10}$ Chaynes answering to a Degree, whereby it appeares that the difference of Longitude betweene *Yorke* and *London* is more then one degree, and to finde how much more, say againe by the Rule of Proportion:

As the measure of a degree,	2245 $\frac{1}{10}$	*co: ar: i.*	6, 64876
is to a degree in *Seconds*,	3600	—— ——	3, 55630
So is the measure given	2333 $\frac{1}{3}$	—— ——	3, 36797
to the number of *seconds*,	3741	—— ——	3, 57303

Which reduced, is 1 Deg. 2 min. 21 *seconds*, and thus we find that *London* doth differ in Longitude from *Yorke*, 1 Deg. 2 min. 21 *sec.* being so much more Easterly.

Thus having the Difference of Latitude, as also the difference of Longitude betweene these two Places, we may (according to the second Probleme of Sayling by *Mercators Chart*) find the Rumbe from *London* to *Yorke*, to be 14 Degrees 20 minutes from the North to the Westwards; that is, North by West 3 degrees 5 minutes Westerly, and the distance in that Rumbe 9442 Chaynes. But their distance in the High-way by reason of the crookednesse and un-evennesse of it, was more by about an eight part.

And the like might bee done for other intermediate Places betweene these, but effecting brevity wee passe that over, as not much pertinent to our present purpose, onely expressing the Latitudes of some of the principall of them, as followeth.

	Latitudes.
As the Latitude of *Yorke*, wee find to be —	53 deg. 58 min.
Doncaster — — — —	53 deg. 32 min.
Newark upon *Trent* — — —	53 deg. 5 min.
Grantham — — —	52 deg. 54 min.
Stamford — — —	52 deg. 38 min.
Huntington — — —	52 deg. 19 min.
Royston — —	52 deg. 4 min.
Ware — —	51 deg. 48 min.
London — —	51 deg. 30 min.

Wee further noted in this Experiment, that howsoever the number of Miles betweene *Ware* and *London*, are almost the same by estimation that they are by measure; yet all the way besides from *Yorke* to *Ware*, a measured Mile consisting of 320 Poles is but three quarters of a Mile, as the miles lye by estimation or common account; so that every where (for the most part) three Miles by estimation make foure measured miles. And a Minute or the sixtieth part of a Degree, is almost in the middle betweene them both; So that looke how much a measured Mile is lesse then a Minute, so much or somewhat more is a Mile by estimation greater then a Minute; for as there is contayned in a Degree, of measured Miles 69 ½ and somewhat more, as we have before shewed, so of our common estimated Miles, there are contained about 51 ½ in a Degree.

Upon these grounds the whole Map of this Kingdome might bee much rectified, especially in the Latitude of Places; for though wee cannot heere determine certainly the Latitudes of any other places besides those which were in the way, or at least in sight as wee came up, (the principall of which we have before noted.) Yet we may nearely conjecture the Latitudes of most parts of *England*, by their Distances and Positions from these; but these things being besides our scope and purpose in this place, wee shall onely compare the Latitude of some principall places probably gathered from this Experiment, with the Latitudes of the same Places, as they are set downe by Mr. *Speed*. in his *Geographicall* Descriptions of *England*; that such as please to examine both in any particulars, may know to which they may more safely leane.

Canterbury.

	Latit. by Celus Exp.		Lat. by M. Sp. Map.	
	D.	M.	D.	M.
Canterbury.	51	17	51	29
Chichester.	50	48	50	51
Guilford.	51	22	52	20
Wincheſter.	51	03	51	11
Dorcheſter.	50	40	50	44
Exceſter.	50	43	50	46
Wells.	51	12	51	22
Salisbury.	51	04	51	12
Redding.	51	28	51	42
London.	51	30	51	45
Colcheſter.	51	58	52	10
Ipſwich.	52	08	52	30
Norwich.	52	42	53	10
Cambridge.	52	12	52	32
Hertford.	51	49	52	06
Bedford.	52	08	52	30
Buckingham.	52	00	52	20
Royſton.	52	04	52	24
Oxford.	51	46	52	02
Gloceſter.	51	53	52	12
Hereford.	52	07	52	27
Worceſter.	52	14	52	36
Warwick.	52	20	52	45

	Latit. by Ship. Exp.		Lat. by M. Sp. Map.	
	D.	M.	D.	M.
Northampton.	52	14	52	36
Huntingdon.	52	19	52	44
Stamford.	52	38	53	04
Leiceſter.	52	40	53	06
Lincolne.	53	14	53	30
Newark upon Trent.	53	05	53	38
Nottingham.	53	00	53	32
Darby.	52	58	53	30
Stafford.	52	52	53	22
Shrewsbury.	52	47	53	16
Cheſter.	53	16	53	52
Lancaſter.	54	10	54	57
York.	53	58	54	44
Richmond in Yorkſhire.	54	28	55	18
Kingſtone upon Hull.	53	48	54	29
Doncaſter.	53	32	54	12
Durham.	54	50	55	45
Carlile.	55	00	55	56
Newcaſtle.	55	03	56	01
Barwick.	55	54	57	03

The Latitudes of theſe Places in the firſt Colume expreſſed, are ſuch as are probably gathered from this Experiment. But in

in the second Colume, there is set downe the Latitudes of the same places as they are expressed by Mr. *John Speed* in his Map of *England*, set forth in his Booke entituled, *The Theatre of the Empire of Great Britaine*, and least there should bee any mistake in his Map, I have conferred these Latitudes thence gathered, with the Latitudes of the same Places set downe by him in words at large in his Descriptions of each severall County, and finde them neerely to agree except in the Latitude of *Barwicke*, which in his Map hee makes to be 57 degrees 03 min. but in his Historicall Description of *Northumberland*, hee relates it to bee 55 degrees 48 minutes, which last is much neerer the truth; but seemes not to be his meaning; because then he should make it more Southerly then *Newcastle*. Yea more Southerly then hee doth *Carlile*, which by his Map, and also by his words in his Relation of *Cumberland*, is in the Latitude of 55 deg. 56 minutes. Whereas *Barwicke* is above fifty Miles more Northerly.

By these you may nearely conjecture the Latitudes of other parts of *England*, lying in or neare the same Parallel with any of them: And hence also it appeares, that the difference of latitude betweene *Barwick*, and the South-coast of *England* neare *Christ-Church*, is little more then 5 Degrees; not 6 Degrees and more, as some of our Maps make it. But these things wee must leave, that we may proceed to that which is principally intended, onely wee will first touch a little upon the use of the foregoing Table in Plotting and Surveying of Land.

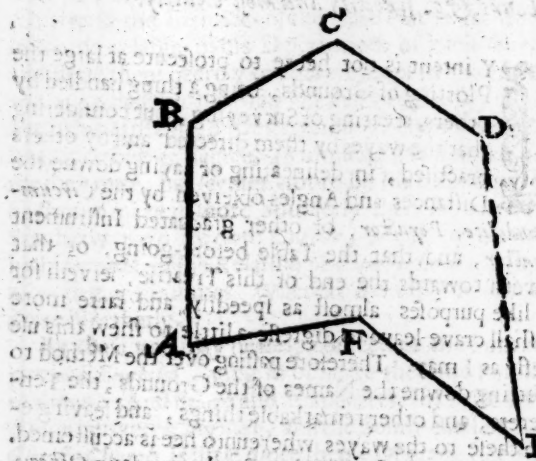
Chap. V.

To Delineate the Plot of any Forrest, Parke, Common, or other peeces of Ground; as also of Rivers, Harbours, &c. speedily and most exactly.

MY intent is not heere to prosecute at large the Plotting of Grounds, being a thing handled by others, treating of Surveying, but considering that the wayes by them directed and by others practised, in delineating or laying downe the Distances and Angles observed by the *Circumferentor*, *Theodolite*, *Peractor*, or other graduated Instrument is by a *Protractor*, and that the Table before-going, or that which followeth towards the end of this Treatise, serveth for that and the like purposes, almost as speedily, and farre more exactly: I shall crave leave to digresse a little to shew this use of it, as briefly as I may. Therefore passing over the Method to bee used in setting downe the Names of the Grounds, the Tennants, Borderers, and other remarkable things, and leaving every man in these to the wayes whereunto hee is accustomed. You may (as sometimes I doe) make a Booke in a long *Octavo*, and upon the left side thereof, set downe such things as these before-mentioned, reserving every right side, and dividing them by Ruled lines into sixe Columes, as hereafter following appeareth.

And having taken and set downe your notes in the Field on the left sides or pages of your Booke, you may in the Evening or next Morning before you goe out, or when else your occasions will permit, set downe in the first Columes on the right side, how many Degrees the Lines upon which you have traverled, are distant from the North or South part of the Meridian towards the East or West, and in the second Columes, the quantity of the same Lines in Chaines, Chaynes, and single Poles, and parts of Poles.

As in this Figure, ſuppoſe the Line from *A* to *B*, to be directly East ſeaven Changes, that is, ſeven times 30 Poles, or 210 Poles; from *B* to *C* to the Eaſtwards of the South 35 degrees 8 Changes and one Chayne; from *C* to *D*, to the Weſtwards of



the South 32 deg. five Changes and foure Chaynes; from *D* to *E*, to the Weſtwards of the South 80 deg. tenne Changes; from *E* to *F*, to the Eaſtwards of the North 35 deg. ſix Changes, three Chaynes, and two thirds of a Pole. And laſtly, from *F* to *A*, the place where I firſt began to the Weſtwards of the North 9 deg. 5 Changes, 3 Chaynes, $2\frac{1}{3}$ Poles; All theſe I expreſſe in the firſt and ſecond Columes on the right ſide, as hereafter following appeareth.

Which done, I take the Table and find there the Northing and Southing, Eaſting or Weſting anſwerable to theſe Degrees and Diſtances, and ſet them downe accordingly. As for the firſt being Eaſt ſeaven Changes, I ſet downe in the Eaſt columne 210 Poles

Poles with a Cipher behind it. For the second being *S E*, 35 deg. I find in the Table for 5 Changes 1228, to bee set in the South colume, and 860 for the East colume; also upon the same degree for 1 Chayne 25 for the South colume, and 17 for the East colume: And so I proceed with all the rest, untill I have finished.

Deg.	*Dist.*	*North.*	*South.*	*East.*	*West.*
East.	0			2100	
S E. 35	2		1228	0860	
			0025	0017	
S W. 32	0		1272		0795
	4		0102		0064
S W. 80	0		0521		2954
N E. 35	3	1474		1032	
	2	0074		0052	
	3	0005		0004	
N W. 09	3	1481			0234
	2 1/2	0089			0014
		0025			0004
		3148	3148	4065	4065

And being thus returned to my first Station, I summe up severally these foure Columnes, of North, South, East, and West; and finding that the summe of the North colume is equall to that of the South, and the summe of the East is equall to that of the West, I conclude the whole Worke to be truly performed, whereas if there had beene any difference, it had shewed an Errour, and if that difference had beene great, it had beene necessary to examine the worke againe, and so to correct it.

It is usuall to adde together all the Angles, and also to multiply two right Angles, or 180 Degrees by the number of Angles lacking two, and if the summe of the Angles added together be equall to this Product, the worke is thought to be true, as here if wee adde, the inclinations and reclinations of these Lines in this Figure, the summe is 720 deg. or 8 right Angles, and if wee multiply two right Angles by 4, (because heere are 6 Angles) the Product is also 8 right Angles. But the other by the summes of the columes, is a most absolute way for examining the truth of your worke, and to bee preferred before any other that I know.

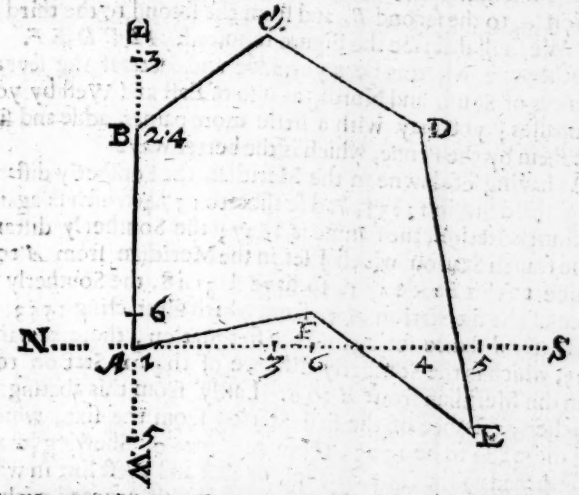
It may seeme very laborious to set downe every Station in this manner, but one that is a little exercised in it may as I take it (for I never observed the time exactly) set downe forty or fifty Stations in this manner, within the space of an houre or thereabouts; but I should advise that it be done by two men having each a Table for that purpose to avoyd all mistakings.

If your Instrument give not the Angle with the Meridian expresly; yet it may easily be gathered thence, or else you may devide a Circle as your Instrument is devided, and number the Degrees as they are there numbred, which done, number them also from the North and South part of the Meridian towards the East and West, so shall you easily know the Angle of any degree with the Meridian.

Now to proceed, these Measures may be set downe in a Plot severall wayes. As first, considering which way the ground lyes, I take a point for my first Station, so as the whole may fall conveniently within the plot, which let be the point *A*, by which point I draw a Meridian and Parallel, namely two right lines intersecting one another at right Angles; whereof let *N S* be the Meridian running North and South, and *E W* the Parallel running East and West, this done, I looke to the North and South columes, and there first in the South columne, and against the third Station, I finde 1253. that is 125 ½. Poles, this I set in the Meridian from *A* to the Southwards, and marke the point with the figure 3, then in the South columne against the fourth

Station,

Station. I find 1374, which J ſet in the Meridian from 3 to 4; alſo againſt the firſt Station, J find 521, which I ſet in the Meridian from 4 to 5. Then againſt the ſixt Station, I find in the North colume 1553, which J ſet in the Meridian from 5 to 6; alſo againſt the ſeaventh Station which is the ſame; with the firſt I find 1595, which J ſet in the Meridian from 6 and it falls upon *A*, which is the firſt Station, and thus J have done with the South and North columes.



In like ſort I expreſſe the meaſures in the Eaſt and Weſt columes in the Parallel *E W*. As finding firſt in the Eaſt colume 2100, I ſet it downe from *A* to the Eaſtwards, and it extends to *B*, where J ſet 2, ſignifying my ſecond Station, I find next in the Eaſt colume 877, which I ſet in that Parallel from 2 to 3; next in the Weſt colume 859, which I ſet in that Parallel from 3 to 4, and ſo J proceed with the reſt. And having thus ſet downe the meaſures in the Meridian and Parallel, we have alſo as it fals out in this example two Stations expreſt, namely *A* and *B*,

now for the third, I take in the Parallel with my Compaſſes the diſtance *A* 3, and ſetting one foot in the Meridian at 3, I ſtrike an Arch neere *C*; alſo taking in the Meridian the diſtance *A* 3, and fixing one foot in the Parallel at 3, I croſſe the aforeſaid arch neare *C*, the interceſſion of theſe two Arches is the point *C*, repreſenting the third Station.

In like ſort, I proceed to find the points *D E F*, for the fourth, fift, and ſixt Stations, then drawing Lines, namely from the firſt Station *A*, to the ſecond *B*, and from the ſecond to the third *C*, &c. We ſhall deſcribe the Figure required, *A B C D E F*.

Otherwiſe, whereas here you adde and ſubtract the ſeverall diſtances of South and North, as alſo of East and Weſt by your Compaſſes; you may with a little more paines, adde and ſubtract them by the Penne, which is the better way.

As having ſet downe in the Meridian the Southerly diſtance of the third Station 1253, I adde thereto 1374, which is againſt the fourth Station, the ſumme is 2627; the Southerly diſtance of the fourth Station, which I ſet in the Meridian from *A* to 4. Againe, to this I adde 521, ſo have I 3148, the Southerly diſtance of the fift Station *A* 5, from which ſubtracting 1553, the Northerly diſtance ſet againſt the ſixt Station, there remaines 1595, which is the Southerly diſtance of the ſixt Station to be ſet in the Meridian from *A* to 6. Laſtly, from this abating, the Northerly diſtance of the firſt Station from the ſixt, which I find there alſo to be 1595, there remaines 0. Shewing that I am returned to the ſame Parallel, or Eaſt and Weſt line in which at firſt I began. And in like ſort, you may proceed with the Eaſt and Weſt columes, and then by the interſection of two Arches, find every Station as before.

Other wayes might bee preſcribed which will not be hard to finde of your ſelfe. And as we may thus lay downe any irregular right lined Figure farre more exactly then by the *Protractor*; So when it is layd downe after this manner, wee may caſt up the *Area* or Superficiall quantity of it very exquiſitely; Yea if there ſhould be a Plot drawne (according to the Angles and Diſtances heere given) after the uſuall manner by a Scale

Scale ſo large, that the Plot ſhould be a hundred times ſo great as this; Yet could not the content thereof be caſt up ſo exactly and certainly, as it may be heere.

But I muſt not inſiſt upon theſe things, they may of themſelves be conceived, and mine intent is onely to touch them, that I be not prevented of Time, and by other occaſions from handling thoſe things which I have heere more ſpecially intended.

But as I have ſayd, this courſe is chiefly to be uſed in Plotting large Grounds, and there indeed are graduated Inſtruments eſpecially to be uſed: For other ſmaller Grounds, there is none more fit then the *Plaine-Table.*

Chap. VI.

Of the Compaſſe of the Earth, and the quantity of a Degree, according to the moſt approved Experiments, Ancient and Moderne.

ALthough the compaſſe of the Earth hath beene in ſome ſort obſerved by divers of the Ancients: Yet for ſome of them wee cannot certainly gather what Meaſures they uſed; others uſed no Meaſure at all, but aſſumed the Diſtance of Places to be ſuch as it was eſtimated by Travailers to be, and likewiſe the Latitude; Therefore it will be needleſſe to inſiſt upon the examination of their Obſervations; others of them which were taken by Meaſure, and which wee may upon any good Ground reduce to our Meaſures, are theſe which follow.

Willebrordus Snellius in his Booke entituled *Eratoſthenes Batavus*, cites *Abel Fedas*, a moſt diligent Arabian Geographer, that lived about the yeare of Chriſt 1322, who records, that about

about the yeare of Christ 827, certaine men skilfull of the *Mathematicks*, did by the commandement of their Prince *Almanon*, measure in the Fields of *Mesopotamia* (as hee gathers) under one and the same Meridian, from the North towards the South, the quantity of a Degree, and found it to be 56 Miles or somewhat more. The quantity of their Mile according to *Alphragranus*, was 4000 Cubits, or 6000 Feet: whence the quantity of a Degree should be 336000 feet, but of the length of their Feet we are something uncertaine, onely they define it to be so long as the extent of 96 Barley cornes layd side by side; whereas the *Rhynland*-foot according to tryall by him made, is but the extent of 90 Cornes layd in like manner, so that if there be no inequality in the graines, then 50 *Arabian*-feet are equall to 96 *Rhynland*-feet. But 96 *Rhynland*-feet are found to be about 91 $\frac{1}{2}$ *English*-feet; therefore also by the rule of Proportion, 336000 *Arabian*-feet doe make of our English-feet 370222. So that according to this experiment of the *Arabians*, a Degree should containe 370222 of our English-feet. And before wee have found by the Observations taken at *London* and *Yorke*, and by the distance of their Parallels measured, that a Degree containes of our English-feet 367200. The difference is onely 3022 Feet, that is about the $\frac{1}{122}$ part of a Degree or halfe a minute.

He cites next *Alhazen* the Arabian, who in his booke *de Crepusculis*, declares the compasse of the Earth to be 24000000 Paces; so that proportionally there must be in one Degree 66666$\frac{2}{3}$ paces, that is, 333333 *Arabian*-feet. And seeing that 90 Arabian feet make of our English-feet 99 $\frac{1}{2}$; therefore by the Rule of Proportion 333333 Arabian-feet, make of our English-feet 367283. So that according to *Alhazen*, there should bee in a Degree 367283 of our English feet, differing from the Experiment which I made onely 83 feet in a Degree.

I have not strained these numbers to bring them to this neerenesse, they are the same in effect, which are set downe by *Snellius* in his *Eratosthenes Batavus* who with great industry and judgement hath compared the Measures of the Ancients, and the measures used by severall Nations in these times with the

Rhyn-

Rhyuland foot. Much leſſe have I ſtrained mine owne numbers to draw them up to theſe; But on the contrary, I confeſſe upon the ſight of his Booke, obſerving the great paines and induſtry which hee profeſſeth himſelfe to have beſtowed, and which I doubt not but he did employ in making his Experiment, and how he had found the meaſure of a Degree to be much leſſe then mine as we ſhall after ſhew, I began to doubt, that I had not made ſufficient allowance for the unevenneſſe of the wayes, and for ſome ſmall bendings, ſometimes to the right hand, ſometimes to the left, the obſervation whereof, I wittingly neglected to ſpare time and expence. For I did often obſerve a mile or two before me, ſome marke in the High-way noting the degree and meaſuring to it in the way, neglecting to obſerve the intermediate ſwarvings of the way, ſomtimes three or 4 Degrees towards the right hand, ſometimes as much to the left, but making ſuch allowance for that, and for the unevenneſſe as I judged ſufficient. And ſome men may thinke that the exact Obſervation of theſe leſſer things thus neglected and regulated onely by judgement or conjecture might deceive me much: But they may conſider, that if there be two Places a mile diſtant, that is in a right line 320 Poles, if you meaſure from one of theſe places towards the other, not in that right line, but alwayes ſwarving from it by an Angle of 4 Degrees ſometimes to the right hand, ſometimes to the left, till you come to that other place; I ſay, that notwithſtanding all theſe ſwarvings (if there be nothing elſe to augment the meaſure) it will not amount to 321. Now conſidering that I had all the way as occaſion required, made ſuch allowance as ſeemed convenient, and ſo found 367200 Feet in a degree, before I compared it with the meaſures taken by any other: I reſolved not to diminiſh nor to augment the number thus ariſing by my Obſervations, Meaſures and allowances in reſpect of the Opinions, obſervations, or meaſures of any other man, untill there be made ſome Experiment more evident and exact then any yet extant. And I am ſomething the more confirmed by the neare agreement of theſe two teſtimonies before recited, both exceeding me a little in the meaſure of a Degree. But we cannot con-

fidently reſt upon them, becauſe of that inequality which may be of Cornes or Graines, for theirs may haply be ſomething greater or leſſer then ours.

Both theſe meaſures of a Degree doe much exceed the quantity of a Degree found by *Snellius*, but when hee compares them with his owne another way, namely placing the Barley-cornes ſo that they may not lye flat but bee ſet up edge-wiſe, and ſo by 96 Cornes to make a Foot, and by ſuch feet to meaſure a Degree; then he finds that the quantity of a Degree according to the *Arabians*, is much leſſe then by his Experiment it ſhould be: but if ſome be layd flat, and others ſet up edge-wiſe, the Arabian meaſure of a Degree will agree with his. And ſo he propoſeth this doubt, whether the 96 Graines whereof the Arabian foot doth conſiſt, muſt lye flat or be ſet up edge-wiſe, or ſome of them to lye flat, and others to be ſet up edge-wiſe. But it is moſt probable that they muſt lye flat, that being the Poſition which they are apt unto by nature; they cannot be ſet edge-wiſe without much trouble, eſpecially ſo many together as make the length of a Foot, and ſo the Arabian meaſure of a Degree doth nearely agree to this of mine.

We come next to heare the determination of *Ptolomey* of *Alexandria*, whoſe Authority and credit in the Solution of this queſtion is not inferiour to any of the Ancients. He affirmes the Compaſſe of the Earth to be 180000 *Stadiums*, and the quantity of a Degree 500 Stadiums, the ſame (as *Strabo* ſaith in his 2. Booke of *Geography*) was before affirmed by *Poſidonius*. Alſo *Marinus Tyrius* (before *Ptolomey*) had determined the quantity of a degree to be 500 Stadiums. *Ptolomey* confirmes it, not ſimply from their Relations, but as it ſeemes from his owne Experience, and that by ſome meaſures diligently taken, for in the 11 Chapter of the firſt booke of his Geography, hee hath theſe words; *Sed in hac quoq; recte ſentit, partem unam qualium eſt circulus maximus tricentorum ſexaginta; quingenta in terra conſtituere Stadia, id enim confeſſis dimenſionibus conſonum exiſtit.* Alſo *Lib. 7. cap. 5. Ita ut pars una, ſeu gradus unus quingenta continent Stadia, quemadmodum ex diligentibus deprehenſum eſt dimen-*

dimenſionibus. Now a Stadium not onely amongſt the *Greekes*, but as appeares by *Herodotus* amongſt all other Nations of *Aſia*, and in *Egypt*, did conſiſt of 600 Feet; therefore a Degree according to *Ptolomey*, muſt containe 360000 Feet: But the *Egyptian*, or *Alexandrian* Foot, was much greater then our Foot; for as we have before ſayd, the ancient *Roman* Foot is greater then ours, and the *Egyptian* Foot was much greater then the *Roman*: For it is often teſtified by *Hero Mechanicus*, that five Alexandrian feet, make ſixe Roman feet. And Mr. *Snellius* hath very ingeniouſly gathered both from *Phylandes* and otherwiſe, that the *Rhynland* foot is equall to the ancient Roman foot; therefore alſo five *Alexandrian* feet are equall to ſixe *Rhynland* feet: So that by the Rule of Proportion, 300000 Alexandrian feet will make of *Rhynland* feet 360000. But by the ſize of our *Engliſh* Foot which was ſent him from the Iron Standard in *Guild-Hall*, hee finds it to containe but 968 ſuch parts as the *Rhynland* containes 1000: So that 968 *Rhynland*-feet are equall to 1000 *Engliſh*, or 121 *Rhynland*-feet are equall to 125 Engliſh-feet. Therefore alſo by the Rule of Proportion, 360000 Rhynland-feet, are equall to 371900 of our Engliſh feet. Therefore according to *Ptolomey*, there are contained in a Degree 371900 of our Engliſh feet. But by our fore-mentioned Experiment made betweene *Yorke* and *London*, wee find onely 367200 Feet in a Degree, being leſſe then *Ptolomies* by 4700 Feet, that is by $\frac{1}{77}$ part of a Degree, or $\frac{1}{4}$ of a Minute and little more.

Fernelius a moderne Author and learned Phyſician, meaſuring the way by the Revolutions of a Wheele, and the Latitudes by Obſervation, finds in a Degree 68 *Italian* miles, and 96 Paces, the Pace which hee uſed being more then five of our Engliſh feet: But becauſe he handled not the Problem exactly, and is ſuſpected by *Snellius* (though I thinke without cauſe) to have grounded his Concluſion rather upon the Experiment of the *Arabians* before ſet downe (wherewith it doth nearely agree) then upon his owne, we will inſiſt no longer upon it.

We come in the laſt place to the Experiment of *Willebrordus Snellius*, a *Hollander*, made in the *Netherlands* about 20 yeares

past. We shall not need to recite the particulars of it, being extant at large in his Booke before-mentioned, but in Conclusion he findes in a Degree 342000 *Rhynland* feet. Now a *Rhynland* foot (as he hath there shewed, comparing both together) is greater then ours, and that in such Proportion, as 1000 is to 968, (and so much or little more it appeares to bee by that Modell of the *Rhynland* Foot printed in his Booke,) therefore 968 Rhynland feet must make 1000 of ours; and hence by the Rule of Proportion, 342000 Rhynland feet will make of our English feet 353305. So that there should be in a Degree onely 353306 Feet, which is lesse then we have before found in a Degree by 13894 Feet, that is by $\frac{1}{25}$ parts of a Degree or $2\frac{1}{2}$ Minutes and something more. Hee was a man doubtlesse of singular industry and knowledge, and of much exercise in the Mathematicks, and it may be, was well experienc'd in this particular, touching the Geometricall mensuration of Distances, and hee hath bestowed much paines and diligence in this Experiment, as by his Booke appeareth. But if he had by a Chayne measured the Distance of his two utmost Stations (if the ground would permit, which I suppose it would not) or at least-wise if his measured Stations had been farther distant: I conceive he would have found a greater Distance in his two utmost places of Observation. But if a man intending to find the Distance of two places, measure onely the $\frac{1}{100}$ part of that distance, and by that measured Line and the Angles think to finde their true distance; Whether he doe it immediately from those two measured Stations, or mediately by helpe of others observed from them, he may easily fall into some notable errour. For though the Probleme bee exactly true in Geometricall Demonstration, how small soever the measure be. Yet it is not so insensible and experimentall practices by reason of the weaknesse even of the best eye, & the imperfection of the instruments in themselves and in their use. And besides that, there were many Stations obliquely scituate; A man cannot alwayes hit the just middle of that Turret-Steeple, or other marke which he observes; Neither when he comes to make his Station there, can he alwayes place his Instrument just at the concourse of his former

mer visuall Lines, by reason of other impediments. Besides the Force of the Winde in such eminent places: adde moreover that amongst so many Steeples as there are in some Townes there, a man may at sometime mistake one for another. And if there should happen no notable Errour, by reason of any or of all these Casualties: Yet may two minutes in the difference of the Latitude of two places be easily mistaken; especially being derived from the Latitudes of those two places which are very rarely set downe true to a minute.

If it be objected, that I might aswell be so much mistaken in the difference of the Latitudes of *Yorke* and *London*.

I answer, it is not so likely, because I had the opportunity of observing the Summer Solstitiall Altitude of the Sunne in both places, wherein I had no necessary use of the Sunnes Parallax, nor Refraction, nor of the Table of the Sunnes Declination, any of which may cause more then a minutes errour, in finding the Latitude of eyther place.

Besides, if mine Errour in those observations should be full asmuch, yet would it not in the Conclusion be halfe so much, because the difference in Latitude of the two places of mine Observation, is more then twice so much as that of his.

But let this suffice, leaving every man to embrace that which he shall best approve. Both our experiments doe sufficiently convince, that common errour of accounting onely 300000 *English* Feet to a Degree, besides the consent of other Observations before recited ancient and moderne.

Mr. *Snellius* hath further in that Booke of his entituled *Eratosthenes Batavus*, with much diligence compared some ancient Measures, as also the measures of sundry Forraigne-Countryes with the *Rhinland-foot*; and amongst the rest of our *English-foot*, according to a size thereof to him sent from the *Standard* in *Guild-Hall* (from whence also I had about 20 yeares past the size of that foot which I have used in this measure) we shall not need to repeat them all because his booke is extant; some of them are these following, which we heere compared to our *English-foot*, as he hath there done to the *Rhynland*, that so any of

them may the more eafily be reduced into our feet. Therfore dividing the *Engliſh foot* into 1000 equall parts, we ſhew how many of thoſe parts are contained in other ancient and forraine feet.

Ancient feet compared with our Engliſh-foot.

Of ſuch parts as the Engliſh foot containes	1000
The Ancient *Roman-foot* contained	1033
The Ancient *Greeke-foot* containes	1076
The *Babilonian* cont.	1211
The *Alexandrian* cont.	1240
The *Antiocheanc*ont.	1405
The *Arabian* cont.	1102

Forraigne feet compared with our Engliſh.

Of ſuch parts as the Engliſh-foot containes	1000
The *Rhinland-foot* containes	1033
The *Dort-foot* cont.	1085
The *Middleburge-foot* cont.	992
The *Amſterdam-foot* con.	934
The *Antwerpe-foot* cont.	939
The *Lovaine* Foot containes,	939
The *Hafnian* Foot in *Denmarke*,	965
The *Paris* Foot called the *Kings Foot*,	1090
The *Venice* Foot,	1157
The *Toledo* Foot,	896
The *Norimberg* Foot,	1006
The *Strasburg* Foot,	920

CHAP. VII.

Of dividing the Log-line, and reckoning the Ships way.

There be foure things upon which the Practice of Navigation is eſpecially grounded, namely the knowledge of the Longitude, Latitude, Courſe, and Diſtance. Touching the Longitude, though it may be found by the other three, yet hitherto there hath not beene delivered any generall Rule true and practiceable where-

whereby the Longitudes of places might be immediatly and ordinarily found of themſelves. The Latitudes of places may immediately be found by obſervation of the Sunn and Starres, as we have formerly ſhewed in the Appendix to the *Doctrine of Triangles*; The Courſe by the Compaſſe, the Variation being duely obſerved, wherein we have many good Marriners very expert, this we have alſo handled in the *Doctrine of Spherical Triangles*. The Diſtance runne, is found of it ſelfe by the *Log-line*, whereof we are heere to ſpeake.

The ground of finding the Diſtance runne by the *Log-line*, is meerely conjecturall, being founded upon this opinion, that five of our Feet make a pace, and a thouſand ſuch Paces make a Mile, and that 60 ſuch Miles make a Degree: ſo that a Degree ſhould containe 300000 of our Feet. But it appeares not onely by this Experiment, but even by all others that were diligently taken and their meaſures to us knowne, that there is a greater number of our Feet contained in a Degree.

There be three things (as I conceive) that have cauſed this Errour to be ſo commonly received and tollerated. The one, for that it doth ſomewhat counterpoiſe another contrary errour in the Practice of *Navigation*, namely in the uſe of the *Plane-chart*, for the Errour which is there committed, by making every Parallel equall to the Equinoctiall, and ſo every degree in them greater then they ſhould be; is ſomething moderated by this errour, whereby the meaſure of a degree is eſteemed leſſe then indeed it is.

For inſtance; It is evident by the *Globe*, that the Meridians concurring in the Poles, grow neerer and neerer together as they grow towards the Poles: in ſo much as if two Meridians be diſtant in the Equinoctiall ten deg. that is 600 miles, the ſame Meridians in the Latitude of 35 degr. will be diſtant little more then 490 miles. Now if unto every mile we account according to the former experiment 6120 Feet, then is the diſtance of thoſe two Meridians in that Parallel neere 3000000 Feet. In like ſort in the *Plaine-chart*, tenne degrees of that Parallel (as of all others) is made equall to tenne degrees of the Equinoctiall or Meridian;

ſo

ſo that the diſtance of theſe two Meridians will upon the *Plaine-Chart*, be 600 miles, but one of theſe miles containes onely 5000 Feet, ſo that the diſtance is but 3000000 Feet, equall to the former.

And although theſe errours in other caſes doe not juſtly ballance one another as in this example, yet that of the *Plaine-Chart* is alwayes ſomething moderated by this other, and ſo much the more by how much they are neerer to the foreſaid Latitude. I grant that this is onely ſo, when the courſe is neere unto the Eaſt or Weſt points; but withall, I ſay that this kind of reckoning is (in a manner) then onely uſed: For, he that runnes any courſe neere the Meridian Southerly or Northerly, hath a more certaine way of reckoning; namely his Latitude which he findes dayly by obſervation of the Sunne and Starres; upon which he will depend, either neglecting or at leaſt not regarding his dead reckoning, Yea (it may be) never caſting the *Logge* ſo much as once in ſuch a voyage, having a more ſure ground for his reckoning. But in a Courſe that is neere Eaſt and Weſt (foraſmuch as there is no way diſcovered for finding the Longitude) he is driven of neceſſity to make uſe of his dead reckoning.

We might adde moreover, that the principall Voyages of this kind, I meane of thoſe which conſiſt of Courſes much Eaſterly and Weſterly, as to and from the *Weſt Indies*, and the Parallel of *Cape bon Eſperance* are neere unto this Latitude of 35 degrees; ſo that as ſome of them are more Southerly, others of them are more Northerly.

But to inſiſt no longer upon this, I ſuppoſe a ſecond cauſe to be for that men commonly deſire to have their reckoning before their Ship (as they ſay) that they fall not with a place before they looke for it; And this comes ſo to paſſe whileſt the miles are accounted leſſe in meaſure, and ſo more in number then they are indeed.

And thus, though there may ſeeme to be ſome commodity in theſe errours, eſpecially when they doe neerely ballance one another; Yet becauſe they ſeldome doe ſo, but alwayes leave men in uncertainties, and oftentimes in great perplexity and danger,

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it is much ſafer and better to reject them both, and to embrace thoſe wayes which are evidently grounded upon truth, though there may be in them ſome more difficulty at the firſt. Yet I confeſſe, that hee which reformes one and not another, may ſometimes erre ſo much the more thereby. And I doubt not, but many would reforme them both if they could certainly doe ſo.

Therefore a third cauſe of admitting and retayning this Errour ſeemes to be, for that there hath beene no way delivered from evident and certaine grounds, for the rectifying of it. I doubt not but many have found Errours in their reckonings ariſing from hence, that they account onely 300000 of our Feet to a degree; but not knowing certainly where to lay the fault, have imputed it ſometimes to ill Steerage, otherwhiles to the Variation of the Needle, or to ſome miſtake in their Reckonings, or to ſome errour in their Plots, or to ſome Current or ſuch other accident, and ſo the Errour hath reſted unreformed. Wherefore although the practicall performance of this Probleme for finding the Circumference of the Earth, or the quantity of a Degree on the ſame, have many ſingular uſes which I cannot now touch; yet that which amongſt the reſt I chiefly aymed at, was that wee might have a more ſure and evident ground for dividing the *Log line*, and for reckoning the Ships way or Diſtance runne more truly upon any Rumbe or Point of the Compaſſe then formerly.

And now to apply it to this purpoſe, we have noted before (*Chap.* 2.) that by the Experiment there expreſſed, we find in a Degree on the Circumference of Earth and Sea, 367200 of our Engliſh feet. Wherefore retayning ſtill the ſame diviſion of a degree into 60 Miles or 20 Leagues (as hath been formerly uſed) a Mile will containe 6120 Feet, or 1020 Fathomes: And ſo a League containes 18360 Feet, or 3060 Fathomes; for dividing 367200 by 60, the quotient is 6120 &c. Thus then 60 Miles being a Degree, every Mile is 6120 Feet.

Now ſuppoſing the time of the running out of the *Log-line*, to be meaſured by a halfe-minute glaſſe, if we obſerve how many Feet or Fathom ſhee runnes in halfe a Minute; we may thereby find her way for an houre or foure houres, or for any other time propoſed.

As admit there runnes out of the *Log-line* in halfe a minutes ſpace 51 Feet, or 8 ½ Fathomes, and you would know what way the Ship makes every houre after the ſame rate.

Say by the Rule of Proportion;

If 0½ Minute give 51 Feet:

What gives 60 Minutes. Or,

If 1 Minute give 102 Feet:

What gives 60 Minutes?

And ſo multiplying, you ſhall find 6120 Feet, which is one Mile. Or if you would find her way for foure houres, which is 240 Minutes; ſay,

As 1 Minute is in Proportion to 240 Minutes,

So are 102 Feet to 24480 Feet, or 4 Miles.

Or if you would have it in Fathomes; ſay,

As 1 Minute is in Proportion to 240 minutes,

So is 17 Fathomes to 4080 Fathomes, the Ships way in foure houres. The like is to be conceived, if your Glaſſe be for any other quantity of time above or under halfe a Minute.

Some have thought that the way which the Ship maketh, may be knowne to an old Sea-man by experience (as they ſay) that is by conjecture: Which opinion, makes ſome neglect the uſe of the *Log*, leſt they ſhould be accounted young Sea-men. But as hee that rides often will have ſome neere gueſſe how farre the Pace he rides will carry him in an houre (becauſe hee hath often obſerved it formerly) ſo hee which hath often ſayled and kept an account of the Ships way by the *Log*, will be able to give ſome neare eſtimate of her way without the *Log*. But it is incident to ſome men to have ſuch a conceit of this their eſtimate, that they thinke it more certaine then the Rule it ſelfe, from whence it is derived, eſpecially if it chance to anſwer their expectations at ſome times.

It is thought alſo that the Ships way may be knowne by two markes on the Ships ſide, but this is doubtleſſe very uncertaine, both by reaſon of the ſhortneſſe of the time, and in reſpect of the dead water (as they call it) by the Ships ſide. For the water which is neere the Ship is drawne along with the Ship in her motion,

motion, and ſo much the more by how much it is neerer.

But if any deſire to make tryall of this way, It is to be conſidered, that 17 Foot is $\frac{1}{3\,5\,2\,0}$ part of a Mile; and 10 *ſec.* of a Minute is $\frac{1}{3\,6\,0\,0}$ part of an Houre; therefore, if there be two markes on the Ship ſide diſtant 17 feet, if the Ship runne the diſtance of theſe two markes in 10 *ſeconds*, ſhe runnes a Mile an houre, if in 5 *ſec.* two miles an houre, if ſhe runne that diſtance in 2 *ſec.* ſhee runs 5 miles an houre. And ſo alwayes deviding 10 *ſeconds* by the number of *ſeconds*, in which the Ship runnes that diſtance; the Quotient ſhewes the Miles and parts of a mile run in an houre.

But if the Diſtance of thoſe two markes be 34 Feet, if ſhee runne it in 20 *ſeconds*, it is after a Mile an houre, if in 10 *ſeconds* two miles an houre, if in 5 *ſec.* foure miles an houre; And ſo alwayes deviding 20 *ſec.* by the number of *ſeconds* in which the Ship runnes that diſtance, the Quotient ſhewes how many miles the Ship runnes in an houre. As if the Ship runne that diſtance of 34 Feet in 8 *ſeconds*, then deviding 20 by 8, the quotient is $2\frac{1}{2}$, ſhewing that ſhe runs $2\frac{1}{2}$ miles in an houre. Or, if you can conveniently make the diſtance of the two markes on the Ships ſide to be 51 Feet (for the further they are diſtant, the better) then if the Ship run that diſtance in 30 *ſec.* it is a mile an houre, if in 10 *ſec.* it is 3 miles an houre, and ſo alwayes deviding 30 *ſec.* by the number of *ſec.* in wch the Ship is rūning that diſtance, the quotient ſhewes after that rate how many Miles the Ship runs in an houre.

Otherwiſe you may doe thus, devide 17 Feet into 10 parts, and ſet as many of thoſe parts on the Ships ſide as conveniently you may, (which according to the Ships length will be more or fewer.) Then when the Ship runnes one of thoſe parts in a ſecond of time it is a Mile an houre: when two, it is two miles an houre; when 5, it is 5 miles an houre. And in generall, if you devide the number of parts runne by the time of running accounted in ſeconds, the Quotient ſhewes what number of Miles after that rate are runne in an houre.

As if ſhe runne 30 of thoſe parts in 5 *ſeconds*, it is 6 Miles an houre, for deviding 30 by 5, the quotient is ſixe; ſo if ſhee runne 42 of thoſe parts in tenne Seconds; deviding forty two

by 10, the Quotient is $4\frac{2}{10}$, which ſheweth the Ships way at that time to be after the rate of foure Miles and two tenths of a mile in an houre.

But for keeping this account of time, it may be done either by a Sand-glaſſe for that purpoſe, or by pronouncing certaine words or numbers: As the time wherein a man tels twice 60, pronouncing every number as faſt as hee can conveniently and diſtinctly, is about a Minute, ſo that the time wherein a man is numbring 60 is halfe a minute, or 30 *ſeconds*, (and whileſt a man is numbring two (as, one and twenty, two and twenty) is a ſecond, and ſo whileſt a man is numbring from twenty to thirty, is five *ſeconds*; from twenty to forty, tenne *ſeconds*, &c. but in numbring from one to twenty, you may obſerve the ſame times, as in numbring from one and twenty to forty, and this will not be hard to doe; for whileſt a man pronounceth one and twenty, two and twenty, three and twenty, &c. there remaines a certain impreſſion in the fantaſie, whereby a man is able in the ſame times to pronounce one, two, three, &c. And although this rule of numbring twice 60 for a minutes ſpace be not generall unto all men, becauſe ſome are ſwifter or ſlower in their pronunciation then others: yet after this Example, a man making triall, may frame a rule to himſelfe whereby he may come ſomthing neare the truth.

But leaving theſe, wee come to the diviſion of the *Log-line* according to the halfe minute-glaſſe, which is more uſuall and certaine. And conſidering that halfe a minute is of an houre the $\frac{1}{120}$ part, therefore the ſhips way running 51 Feet in halfe a minute, is a mile an houre; if ſhe runne twice ſo much, that is, 102 Feet in halfe a minute, it is two miles an houre; if thrice ſo much, it is three miles an houre. And in generall how many times 51 Feet ſhe runnes in halfe a minute, ſo many miles is her way for an houre. Therefore leaving halfe a ſcore Fathom or more from the *Log*, that ſo it may be out of the *Eddy* of the ſhips wake, before you begin to account or turne the glaſſe, if there you make a marke for the beginning, and ſo 51 Feet from thence a marke of one knot, and 51 Feet further a marke of two knots, and 51 feet further, (that is 153 feet from your firſt marke) another

another marke of three knots, and ſo proceeding: looke how many knots are veered out in halfe a minute, ſo many miles is the ſhips way for an houre. Now for that which is veered out more above the juſt meaſure of a knot or knots, you may allow for every five Feet, the tenth part of a mile almoſt. As admit ſhe runne five knots and 25 Feet in halfe a minute, then is her way according to $5\frac{5}{10}$ or five miles and a halfe in an houre; if ſix knots and tenne Feet, it is $6\frac{6}{10}$ miles in an houre, &c.

But according to the common opinion of 5000 Feet to a mile, and 60 ſuch miles to a degree, there ſhould be ſomething leſſe then 7 fathom, namely $41\frac{2}{3}$ Feet to a knot.

And although he which veeres the *Log-line* be carefull to overhale it ſo ſlack that it may not draw forwards the *Logge*, yet (no doubt) it doth looſe ſome way, following the Ship a little as it is drawne by the Line, and withall by the *Eddy* of the Ships wake; and ſometimes alſo is caſt forwards by the winde and waves, when they come after the Ship; ſo that for theſe cauſes it is like there may ſometimes be allowed three or foure Fathomes more then is veered out, but this (as a thing mutable and uncertaine) being ſometimes more ſometimes leſſe cannot be brought to any certaine Rule, but ſuch allowance may be made for it as a man in his experience and diſcretion finds fit.

If you would divide the *Log-line* ſo as it might giue the Ships way in *Centeſmes* or the hundreth part of a Degree, and fit it to a halfe Minute-glaſſe. Then ſeeing the hundreth part of a degree is 3672 Feet, and the $\frac{1}{100}$ part thereof is $30\frac{3}{4}$ Feet; If you begin at the marke at which you meane to turne the glaſſe, and meaſure from thence 30 Feet and 3 fift parts of a Foot, you may there place one knot: And thence againe meaſuring 30 Feet, and 3 fift parts of a foot, there place two knots; and ſo proceeding at the end of every 30 feet and three fifts, adding a knot, the number of knots which runne out in halfe a minute, is the number of *centeſmes* which the Ship runnes in an houre. As ſuppoſe there runne out tenne knots in halfe a minute, then the Ships way is according to the *centeſmes* of a degree in an houre, that is the tenth part of a degree or ſix miles. And ſo every three foot above the

juſt meaſure of knots is neare the tenth part of a *Centeſme*, or the 1000th part of a Degree. As if there runne out of the *Log-line* 5 knots and 12 Feet; then the Ships way for an houre is 5 *Centeſmes*, and 4 tenth parts of a *centeſme*, and the like is to bee underſtood of others.

And after the forme of theſe Examples, you may devide the *Log-line* for any other quantity of Time, more or leſſe then halfe a minute, or for any other parts of a Degree propoſed.

Thus have wee handled the deviſion of the *Log-line*, according to the meaſure before found of 367200 *Engliſh*-feet in a degree; But becauſe (as I have before ſhewed) the Ships way is commonly more then by the *Log-line* it appeares to bee: and every man deſires to have his Reckoning ſomething before his Ship, that hee fall not with a place unexpected; For theſe and ſuch other cauſes and for the rotundity of the number, if any man thinke it more ſafe and convenient in Sea reckonings, hee may abate 1 in 51, and ſo aſſigne to a Degree onely 360000 feet, and conſequently to a Mile 6000 *Engliſh*-feet.

And upon this ground, if in halfe a Minute there runne out 50 feet of the *Log-line*, it is a mile an houre; and ſo if 100 Feet runne out in a minute.

For as 1 Minute, is in proportion to 60 minutes:

So is 100 Feet, to 6000 feet.

And ſo foraſmuch as twenty five Feet is $\frac{1}{240}$ part of a Mile, and 15 *ſeconds* is alſo $\frac{1}{240}$ part of an Houre; Therefore if there be two marks on the Ships ſide diſtant 25 Feet, if the Ship runne the diſtance of theſe two marks in 15 *ſeconds*, it is after the rate of a mile an houre; if in 5 *ſeconds*, it is 3 miles an houre, and ſo alwayes deviding 15 *ſeconds* by the number of ſeconds in which the Ship runnes that diſtance, the Quotient ſhewes the Miles and part of a mile, runne an houre. But if the diſtance of theſe two marks be 50 Foot, then if ſhee runne it in 30 *ſec.* or halfe a minute, it is a mile an houre; if in 10 *ſeconds*, three miles an houre; if in five *ſeconds*, ſixe miles an houre, (for 30 devided by 5, the Quotient is 6.) And ſo alwayes deviding 30 *ſeconds* by the number of ſeconds, in which the Ship runnes

that

that Distance; the quotient shewes how many Miles shee runnes in an Houre &c.

Otherwise, if you make a marke on the Ships-side at every twenty Inches, then when the Ship runnes one of these parts in a second of time, it is a mile an houre; when 5, it is 5 miles an houre; if she runne 18 of these parts in 3 *seconds*, it is 6 miles an houre; For deviding 18 by 3, the *Quotient* is 6. And in generall, if you devide the number of the parts runne by the number of *seconds* spent in running, the *Quotient* shewes the Ships way in miles for an houre.

But for deviding the *Log-line* according to this ground of 6000 Feet in a mile, if you intend to use it with a halfe Minute-glasse, then because halfe a minute is $\frac{1}{120}$ part of an houre, and 50 Feet is also the $\frac{1}{120}$ part of a mile; Therefore when the Ship runnes 50 Feet in halfe a minute, her way is after the rate of a mile an houre; if 100 Feet in halfe a minute, it is two miles an houre, &c.

Therefore halfe a score Fathomes or more from the *Logge* you may make a marke, and beginning from thence measure 50 Feet, and there make the first knot, and 50 Foot farther two knots, and 50 foot farther three knots, and so proceeding: Looke how many knots is runne out in halfe a minute, so many miles is the Ships way for an houre. And every 5 Feet more besides the knots is a *tenth* part of a mile; As if there runne out fixe knots and 20 feet in halfe a minute, the Ships way is after the rate of $6\frac{2}{10}$ Miles in an houre &c.

And so if the Glasse were for any other time more or lesse then halfe a Minute, you may make the distance of your knots proportionall. As if it were for twenty *seconds*, then because twenty *seconds* is of an houre the $\frac{1}{180}$ part, I devide a mile which is 6000 Feet, by 180, and the *Quotient* is $33\frac{1}{3}$; therefore there must be a knot at every 33 Feet and 4 Inches.

If your Glasse be 36 *seconds*, which is $\frac{1}{100}$ part of an houre, devide 6000 by 100, the *Quotient* is 60, shewing that there must be 60 Feet to every knot, and then every fixe foot over and above the knots is a *tenth* part of a Mile more.

And

And ſo it is better that your Glaſſe be more then halfe a minute rather then leſſe, and the more the better, provided that there runne out no more Line then you may hale in againe without danger of breaking.

Laſtly, if you would ſo divide the *Log-line*, that it might ſhew the Ships way in *Centeſmes* of a Degree, and fit it to an halfe Minute-glaſſe: Then foraſmuch as the hundreth part of a Degree is 3600 Feet, and the $\frac{1}{100}$ part thereof is 30 Feet: therefore beginning at the marke whereat you intend to turne the Glaſſe, meaſure from thence 30 Feet and there make one knot, and at thirty Feet farther, two knots &c. Then looke how many knots runne out in halfe a minute; ſo many *Centeſmes* of a degree is the Ships way for an houre. And ſo if the glaſſe be 36 *ſeconds*, then every knot muſt have 36 Feet &c.

Now if a man ſayling betweene any two Places which lye neare Eaſt and Weſt one from another, have kept his reckoning by Courſe and Diſtance, uſing a *Log-line* ſo devided, that it have a knot at every 7 Fathomes (as many doe,) and would reduce the Diſtance of thoſe two places ſo found, to their diſtance in ſuch miles as theſe of ſixty to a Degree, each contayning (as we have ſaid) 6000 Feet: The proportion in number of thoſe to theſe, is as 6 to 5; for 6 of them make 5 of theſe.

As admit a man in his dead Reckoning uſing ſuch a *Log-line* as hath a knot at every 7 fathoms, and for every knot running out in halfe a minute, hee accounts the Ships way to be ſo many Miles an houre; and according to ſuch a reckoning, ſuppoſe he find the Diſtance of two places to be 1224 Miles or 408 leagues; and would know the diſtance of the ſame places in Miles of 6000 Feet to a Mile, which is according to a *Log-line* that hath a knot at every 50 Feet.

Say then by the Rule of Proportion;

As the number 6,	*Co: ar:*	9,22185
Is in proportion to 5,		0,69897
So is the number of Miles given 1224		3,08778
To the number of Miles required, 1020		3,00860

Which

Which 1020 is the distance of those two Places, in such Miles whereof 60 make a Degree; Or to find the same in leagues, the proportion is, As 6 to 5, so is 408 leagues to 340 leagues.

And thus may the Distances of places be found in such Miles whereof 60 make a Degree, especially if with the distance expressed in the *Plaine-Chart*, you compare the reckonings of some skilfull Mariners that have sayled from the one to the other. But thus to endeavour a reformation of the Plaine-Chart, were a labour to little purpose; For there the correcting of the true scituation of two Places in respect of one another, is oftentimes an occasion that the same places are the more falsly scituate in respect of others. Like as if there were two places eight miles distant, and it were required to place a third three miles from either of them; heere if we set the third in the middle, it will be foure miles distant from either: but if (attempting to mend that errour) we make the third to be 3 Miles from the first, then will it be 5 Miles from the second; And thus unavoidably, the mending of the one is the marring of the other; because the thing proposed is not possible.

And such is the errour of the Plaine or Common *Sea-Chart*, representing the Earth and Sea, not as a Sphæricall but as a plaine Superficies; not as if the Meridians did concurre in the Poles, but as if they were alwayes Parallel one to another. So that the graduation and projection being such, the Scituations and Distances of places, cannot be generally and truly expressed therein.

But the graduation and projection of *Mercators-Chart*, agreeing without sensible errour with the *Globe*, there may in that be described all or any parts of the World, according to their Longitudes, Latitudes, Courses, and Distances, as truly and farre more conveniently for the Mariners use then upon the Globe it selfe; and upon such a *Chart* so described, a reckoning may be truly kept, and any errour committed may easily be discerned and amended. Whereas on the *Plaine-Chart* if a man find his reckoning to disagree, he is so farre from knowing how to amend it, that he can seldome conjecture where the fault was.

The neglect and want of these *Charts* hath beene and is a great

imperfection in *Navigation* and *Geography*. For howsoever they be some which doe daily set forth for sale Maps of the World, and of the parts thereof, according to this Projection: Yet to have them truly such and fit for Navigation, requires in the Author or maker of them good Knowledge and some competent ability of his owne, or ayd from others, with a greater love to the Truth then to his owne profit, which may induce him to bestow such Industry, time and expence, as I have formerly noted to be requisite in such a Worke.

For the furtherance whereof, and of the Practice of Navigation in generall; I shall endeavour in the two next Chapters to shew a methodicall and orderly way of keeping a reckoning at Sea, more distinctly and exactly then hath beene formerly used, and such as may aptly be set downe in any *Chart*, and applyed in the three principall kinds of Sayling; namely, according to the *Plaine-Chart*, or *Mercators*, or according to the Arch of a *Great Circle*. And by a few reckonings truely set downe according to this forme, the Maps of the World and of the parts of it, might be much reformed.

CHAP. VIII.

A Formall and exact way of setting downe and keeping a Sea reckoning.

ALthough the Course and Distance cannot be so truly and certainely knowne as the Latitude may be: yet wee must endeavour in these also to come as neare the Truth as may be; the rather for that some reckonings must necessarily depend wholly upon them. And to that end, those which in their Voyages at Sea have occasion to runne farre upon any Course or courses neare the Meridian, may doe well to make tryall of that which I have formerly set downe, touching the quantity of a Degree on the Earth and Sea in our knowne Measure; and especially in *East-Indian* voyages, sayling

ling from the *Lizard* in the West part of *England* to *Cape bon Esperance* in *Affrick*, they have opportunity of making an ample experiment hereof.

But leaving this to the practice of the skilfull and industrious *Sea-man*, wee come now to shew an orderly and exact way of framing and keeping a reckoning at Sea: for which purpose, I have made the *Table* following, which sheweth how much a ship is more Northerly or Southerly, and how much more Easterly or Westerly, by sayling upon any point or halfe point of the *compasse*, any number of miles proposed.

The like *Table* I made many yeares since, and taught the use of it in *Muscouia*, whether it were then used by any other, I knew not, I had it of no man, but this I speake if any man claime the first making and use of such an one, he may have it.

The ground of making this Table is the same with the former. *For as Radius is in proportion to the Distance runne: So is the sine Complement of the Rumbe, to the distance of North or South: And so is the sine of the Rumbe to the distance of East or West.* Therefore heere for 10 miles vpon any of the foure points from the Meridian, we set in the second column the sine Complement of that point, (reduced into degrees) and in the third the sine thereof. As the second Rumbe or point of the Meridian, being 11 deg. 30 minutes, the sine Complement thereof which is 9239 set in the second column against 10; And the sine thereof 3827, I set there in the third column, and having done thus, for 10 miles in every column, the rest may be easily drawne from them.

As in the second column, for the first halfe point against 10 miles finding 9952, I set the halfe thereof, namely 4976 against 5 miles, and the tenth part thereof, namely 995 against 1 mile, which doubled or added to it selfe is 1990 to be set against two miles, whereto adding the same 995, the summe is 2985 for 3 miles, and so for the rest.

And thus for every point and halfe point from the Meridian, there are three columes, In the first whereof there is set downe, a number of miles runne vpon that point or halfe point; the second sheweth, how much the Latitude is altered; that

is, how much you are more Southerly or Northerly by running so farre upon that Point or halfe point; The third, how much you are more Easterly or Westerly by running that course and distance.

The Numbers set in every first Colume from 1 to 10, are also to be understood from 10 to 100, or from 100 to 1000; and the Figure in the fourth place of the second and third Columes, answer to the figure in the first. As admit a Ship runne South and by West (that is (South 1 point Westerly) 165 Miles) I set downe this Number thus; and looking in the Columes of the first *Numbe* against 100, (which may be understood to be 100) I find against it in the second Colume 982 almost, and in the third 195; also against 60 (that is 6 in the first Colume there is 588 in the second, and 117 in the third: also against 5, in the first Colume, there is 49 in the second, and almost 10 in the third.

S W. 1 Point,	100	981	195
	60	588	117
	5	49	10
	165	1618	322

These set downe and summ'd up as here appeareth, shew that a Ship running S by W, 165 Miles, is to the Southwards of the place from whence she departed 161 miles and 8 *tenth* parts of a mile, and 30 the Westwards 32 Miles and 2 *tenth* parts of a mile. If you desire more exactnesse, you may use all the places, for the first or greatest number which is here 100.

As in this second Example, where the Southerly distance is 165 Miles, and the Westerly 32 Miles.

S W, 1 Point,	100	9808	1950
	60	5885	1170
	5	490	97
	165	1618	3217

And thus [illegible] Table

A Table of the Northing or Southing, Easting or Westing of every Rumbe and halfe rumbe from the Meridian; according to the number of Miles runne upon that Rumbe.

°	½ Poin	7½ Po	1 Poin	7 Poin	1½ Po.	6½ Po.	2 Poin	6 Poin
M.	5. 37½	84. 22½	11. 15	78. 45	16. 52	73 7½	22. 30	67. 30
1	995	98	981	195	957	290	924	383
2	1990	196	1962	390	1914	580	1848	766
3	2986	294	2943	585	2871	870	2772	1148
4	3981	392	3923	780	3827	1161	3696	1531
5	4976	490	4904	975	4784	1451	4620	1914
6	5971	588	5885	1170	5741	1741	5544	2297
7	6966	686	6866	1365	6698	2031	6468	2680
8	7961	784	7846	1560	7655	2321	7392	3062
9	8957	882	8827	1755	8612	2612	8315	3445
10	9952	980	9808	1950	9569	2902	9239	3827

°	2½ Po.	5½ Po.	3 Poin	5 Poin	3½ Po.	4½ Po	4 Poin	4 Poin
M.	28. 7½	61. 52½	33. 45	56. 15	39. 22½	50. 37½	45. 00	45. 00
1	882	471	831	556	773	634	707	707
2	1764	942	1663	1111	1546	1269	1414	1414
3	2646	1414	2494	1667	2319	1903	2121	2121
4	3528	1885	3326	2222	3092	2538	2828	2828
5	4410	2357	4158	2778	3865	3172	3535	3535
6	5292	2828	4989	3334	4638	3806	4242	4242
7	6174	3300	5820	3890	5411	4440	4949	4949
8	7056	3771	6652	4445	6184	5075	5656	5656
9	7937	4243	7483	5000	6957	5710	6364	6364
10	8819	4714	8315	5556	7730	6344	7071	7071

A larger Example may be that before set downe in the last *Probleme* of Sayling by a *Great Circle*, from *Summers-Ilands* to the *Lizard*, pag. 127.

As admit I sayle from thence, first N E. ½ point Easterly 600 miles: then N E by E, 300 miles; East North-east halfe a point Northerly, 495 miles: East N E, 390 miles; E N E, ½ point *Easterly*, 264 miles; E by N, 110 miles; East 951 miles; These Courses and Distances I set downe in such forme as here appeareth; where in the first colume, there is expressed the Course or Point of the *Compasse* upon which a man Sayles: In the second colume, the Distance of that *Rumbe* from the *Meridian*; in the third colume, the Distance runne upon the *Point*; In the rest, the Difference of *Latitude*, and departure from the *Meridian* in Miles and *tenth* parts of a mile.

Course.	*Rumbe frõ Me.*	*Distan. miles.*	*North.*	*South.*	*East.*	*West.*
N E, ½ Po. E.	North Easterly 4½ P.	600	389.6		463.8	
N E, by E.	N East 5 Points	300	166.7		249.4	
E N E ½ Po. N.	N East 5½ Po.	400	188.5		352.8	
		90	42.4		79.4	
		5	2.4		2.4	
E N E.	N East 6 Po.	300	114.8		277.2	
		90	34.4		83.1	
E N E ½ Po. E.	N East 6½ Po.	100	05.80		19.14	
		60	17.4		57.4	
		4	1.2		3.8	
E by N.	N East 7 Po.	100	39.0		196.2	
		10	2.6		19.8	
		900			951.0	
East.	*East.*	50				
		3180	1047.4			

(In all which is to be conceived, that the *Variations* are allowed) so that at the Foot of this reckoning, I finde the summe of the North columne to be 1047 miles, and the summe of the East columne 2920 miles almost, the first, namely 1047 miles converted into degrees, is 17 degrees 27 min. the difference of Latitude, which added to the Latitude of *Summers-Ilands* 32 deg. 25 min. (whence this reckoning began,) the summe is 49 deg. 52 min. which is the Latitude of this last place where this reckoning endeth. So that according to this account, the Ship is runne into the Latitude of 49 deg. 52 min. and hath altered her Longitude to the Eastwards 2920 miles, of such miles whereof 60 make a degree of a great Circle.

Therefore, if you set downe this reckoning on the *Plaine-Chart*, you must make a point in the *Chart* that may be in the Latitude of 49 deg. 52 min. and to the Eastwards of *Summers Ilands* (where this reckoning began) 2920 miles, that is, you must runne a parallel (with your Compasses or otherwise) on your *Chart* in the Latitude of 49 deg. 52 min. and crosse the same by a Meridian, which may be to the Eastwards of the Meridian of *Summers Ilands* 2920 miles, and so the point of the intersection of this parallel and Meridian, is the Traverse point or point in the Chart representing the place where the Ship is in the end of this reckoning.

But if you set downe this reckoning on *Mercators Chart*, you must also find a point, that may be in the Latitude of 49 deg. 52 min. and may likewise be to the Eastwards of *Summers Ilands* 2920 miles, which is done by running with your compasses a parallel in the Latitude of 49 deg. 52 min. and crossing the same by a Meridian which may be to the Eastwards of the Meridian of *Summers Ilands* 2920 miles, the point of the intersection of this parallel with that Meridian is the traverse point, representing in the Chart the place where the Ship then is.

For it is to be conceived in this *Chart*, that the degrees of the Meridian intersepted betweene the Latitudes of two places are as a scale for those two places, to measure not onely their difference of *Latitude*, but likewise their distance in their *Rumbe*, as also the distance of their *Meridians*.

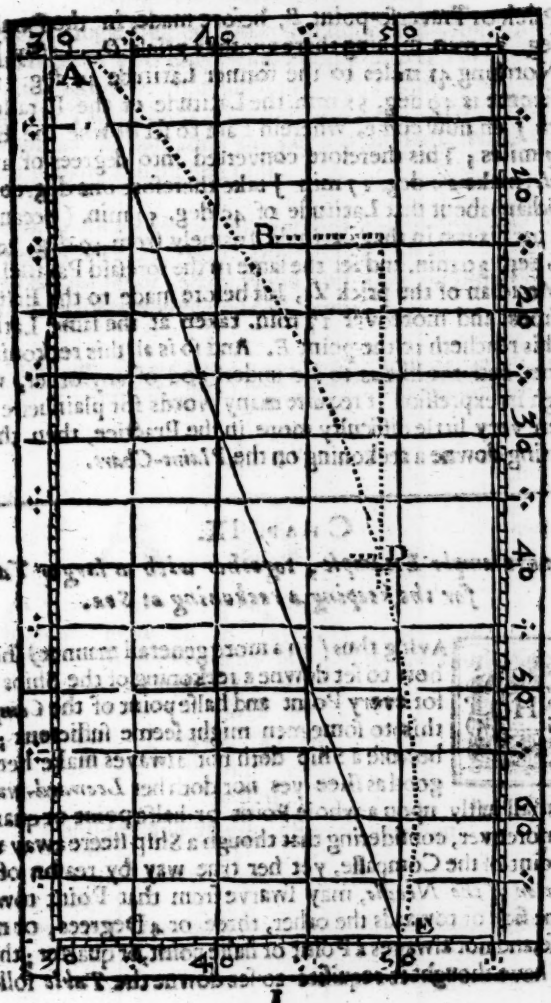
But

But becauſe it often falls out, that in Sayling from place to place, a Ship runnes not neere the Rumbe of the two Places by many hundred Miles, eſpecially in ſayling by the Arch of a *Great Circle*, which is the moſt exquiſite manner of Sayling, and wherein a man ſhifts his Courſe often, and runnes much further in one Latitude then in another, as by the former Example may appeare: Therefore once in three or foure dayes, or ſo often as you alter your Courſe much, you may transferre or ſet downe your reckoning out of your Booke into your *Chart*. As in transferring the former Example, you may ſet downe the Northing and Eaſting of every of the Courſes ſeverally, but for brevities ſake wee will bring them into three parts (and ſo alſo we ſhall not much erre.)

And thus for the two firſt Courſes, namely *N E*, ½ point Eaſterly 600 Miles, and *N E* by *E*, 300 Miles, I find in the North colume 547 miles, and in the Eaſt colume 713 Miles. Alſo for the three next Courſes, ſumming up the North and Eaſt colums, I find the Northing to be 459 Miles, and the Eaſting 1050 miles. Alſo for the two laſt Courſes, I find the Northing to be 41 Miles, and the Eaſting 1157 miles.

	North.	*Eaſt.*
	547	713
	459	1050
	41	1157
	1047	2920

Now to transferre theſe into the *Chart*, I conſider that 547 Miles is 9 Deg. 7 minutes, which added to the former Latitude 32 deg. 25 min. makes Latitude 41 deg. 32 min. In which Latitude I runne a Parallel, then conſidering that 713 Miles is 11 deg. 53 min. I take this 11 deg 53 min. in the Meridian, ſo much above the one Latitude as beneath the other; namely from 31 deg. 00 min. to 42 deg. 53 min. and this I ſet in the foreſaid Parallel from the Meridian of *Summers-Ilands* to the Eaſtwards, and there make the point *B*, then reducing 459 Miles into Deg. it makes 7 deg. 39 min. which added to 41 deg. 32 min. makes Latitude 49 deg. 11 min. Alſo the Eaſting 1050 miles are 17 deg. 30 min. the halfe whereof 8 deg. 45 min. I take in the Meridian from above 41 deg. 32 min. beneath 49 deg. 11 minutes, namely from 41 deg. 20 min. to 50 deg. 5 min. And this being doubled (becauſe it is but the halfe) I ſet from the Meridian of the


30
40
50
A
B
D
E
10
20
30
40
50
60
30
40
50

the Prick or Traverse-point *B*, before made, in the Parallel of 49 deg. 11 min. making there another prick *D*. Lastly I adde the Northing 43 miles to the former Latitude 49 deg. 11 min. the summe is 49 deg. 52 min. the Latitude of the Parallel, to which I am now come, wherein I am to set downe the Easting 1157 miles; This therefore converted into degrees of a *Great Circle*, make 29 deg. 17 min. I take therefore one degree of the Meridian, about that Latitude of 49 deg. 52 min. (because the most part is ran in that Latitude,) namely from 49 deg. 30 min. to 50 deg. 30 min. and set the same in the foresaid Parallel from the Meridian of the prick *D*, last before made to the Eastwards 29 times, and moreover 17 min. taken at the same Latitude, and this reacheth to the point *E*. And so is all this reckoning set downe, and the like is to be understood of any other, which though in expression it require many words for plainnesse: yet is there very little difficulty more in the Practice, then there is in setting downe a reckoning on the *Plain-Chart*.

Chap. IX.

A more ample Example, together with a larger Table for the keeping a reckoning at Sea.

HAving thus (in a more generall manner) shewed how to set downe a reckoning of the Ships way, for every Point and halfe point of the *Compasse*, this to some men might seeme sufficient; But because a Ship doth not alwayes make her way good as shee lyes, nor doth her *Leeward-way* alwayes fall justly upon a whole Point or halfe point or quarter; And moreover, considering that though a Ship steere away upon any Point of the Compasse, yet her true way by reason of the *Variation of the Needle*, may swarve from that Point towards the one side or towards the other, three or 4 Degrees, or more or lesse, and not alwayes a Point or halfe point, or quarter; therefore I have thought it requisite to set downe the *Table* following

ing to every single Degree: and that man might the more readily with one or two Entrances have his desire, I have also enlarged the number of Miles unto 180. The ground and way of making this Table differs not from the former, and it is to bee used almost in the selfe same manner: wherefore wee shall use the more brevity in handling of it.

Heere followeth a Table of the Northing or Southing, Easting or Westing of every Degree from the Meridian: According to the number of Miles runne upon that Degree. Which for brevity sake wee will call ——

A TABLE for the Difference OF LATITVDE, AND Departure from the *Meridian*.

M.	I. D.	89. d.	M.	I. D.	89. d.	Min.	I. D.	89. D.
1	10	0	35	350	6	69	690	12
2	20	0	36	360	7	70	700	12
3	30	0	37	370	7	71	710	13
4	40	1	38	380	7	72	720	13
5	50	1	39	390	7	73	730	13
6	60	1	40	400	7	74	740	13
7	70	1	41	410	7	75	750	13
8	80	1	42	420	7	76	760	13
9	90	2	43	430	8	77	770	14
10	100	2	44	440	8	78	780	14
11	110	2	45	450	8	79	790	14
12	120	2	46	460	8	80	800	14
13	130	2	47	470	8	81	810	14
14	140	2	48	480	8	82	820	14
15	150	3	49	490	9	83	830	15
16	160	3	50	500	9	84	840	15
17	170	3	51	510	9	85	850	15
18	180	3	52	520	9	86	860	15
19	190	3	53	530	9	87	870	15
20	200	4	54	540	10	88	880	15
21	210	4	55	550	10	89	890	16
22	220	4	56	560	10	90	900	16
23	230	4	57	570	10	91	910	16
24	240	4	58	580	10	92	920	16
25	250	4	59	590	10	93	930	16
26	260	5	60	600	11	94	940	17
27	270	5	61	610	11	95	950	17
28	280	5	62	620	11	96	960	17
29	290	5	63	630	11	97	970	17
30	300	5	64	640	11	98	980	17
31	310	5	65	650	12	99	990	17
32	320	6	66	660	12	100	1000	18
33	330	6	67	670	12	200	2000	35
34	340	6	68	680	12	300	3000	53

M.	2. D.	88. d.
1	10	0
2	20	1
3	30	1
4	40	1
5	50	2
6	60	2
7	70	2
8	80	3
9	90	3
10	100	3
11	110	4
12	120	4
13	130	4
14	140	5
15	150	5
16	160	6
17	170	6
18	180	6
19	190	7
20	200	7
21	210	7
22	220	8
23	230	8
24	240	8
25	250	9
26	260	9
27	270	9
28	280	10
29	290	10
30	300	10
31	310	11
32	320	11
33	330	12
34	340	12

M.	2. D.	88 d.
35	350	12
36	360	13
37	370	13
38	380	13
39	390	14
40	400	14
41	410	14
42	420	15
43	430	15
44	440	15
45	450	16
46	460	16
47	470	16
48	480	17
49	490	17
50	500	17
51	510	18
52	520	18
53	530	18
54	540	19
55	550	19
56	560	19
57	570	20
58	580	20
59	590	20
60	600	21
61	610	21
62	620	22
63	630	22
64	640	22
65	650	23
66	660	23
67	670	23
68	680	24

Min.	2. D.	88. D.
69	690	24
70	700	24
71	710	25
72	720	25
73	730	25
74	740	26
75	750	26
76	760	26
77	770	27
78	780	27
79	790	28
80	800	28
81	809	28
82	819	29
83	829	29
84	839	29
85	849	30
86	859	30
87	869	30
88	879	31
89	889	31
90	899	31
91	909	32
92	919	32
93	929	33
94	939	33
95	949	33
96	959	34
97	969	34
98	979	34
99	989	35
100	999	35
200	1999	70
300	2998	105

M.	3. D	87. d.
1	10	1
2	20	1
3	30	1
4	40	2
5	50	2
6	60	3
7	70	4
8	80	4
9	90	5
10	100	5
11	110	6
12	120	6
13	130	7
14	140	7
15	150	8
16	160	8
17	170	9
18	180	9
19	190	10
20	200	10
21	210	11
22	220	11
23	230	12
24	240	12
25	250	13
26	260	13
27	270	14
28	280	15
29	290	15
30	300	16
31	310	16
32	320	17
33	330	17
34	340	18

M.	3. D.	87. d.
35	350	18
36	360	19
37	370	19
38	380	20
39	390	20
40	400	21
41	410	21
42	420	22
43	430	22
44	440	23
45	450	23
46	460	24
47	470	24
48	480	25
49	490	26
50	500	26
51	509	27
52	519	27
53	529	28
54	539	28
55	549	29
56	559	29
57	569	30
58	579	30
59	589	31
60	599	31
61	609	32
62	619	32
63	629	33
64	639	33
65	649	34
66	659	35
67	669	35
68	679	36

Min.	3. D.	87. D.
69	689	36
70	699	37
71	709	37
72	719	38
73	729	38
74	739	39
75	749	39
76	759	40
77	769	40
78	779	41
79	789	41
80	799	42
81	809	42
82	819	43
83	829	43
84	839	44
85	849	44
86	859	45
87	869	45
88	879	46
89	889	46
90	899	47
91	909	48
92	919	48
93	929	49
94	939	49
95	949	50
96	959	50
97	969	51
98	979	51
99	989	52
100	999	52
200	1997	105
300	2996	157

M.	4. D.	86. d.
1	10	1
2	20	2
3	30	2
4	40	3
5	50	3
6	60	4
7	70	5
8	80	6
9	90	6
10	100	7
11	110	8
12	120	8
13	130	9
14	140	10
15	150	10
16	160	11
17	170	12
18	180	13
19	190	13
20	200	14
21	209	15
22	219	15
23	229	16
24	239	17
25	249	17
26	259	18
27	269	19
28	279	20
29	289	20
30	299	21
31	309	22
32	319	22
33	329	23
34	339	24

M.	4. D.	86. d.
35	349	25
36	359	25
37	369	26
38	379	27
39	389	27
40	399	28
41	409	29
42	419	29
43	429	30
44	439	31
45	449	31
46	459	32
47	469	33
48	479	34
49	489	34
50	499	35
51	509	36
52	519	36
53	529	37
54	539	38
55	549	38
56	559	39
57	569	40
58	579	40
59	589	41
60	599	42
61	609	43
62	619	43
63	629	44
64	639	45
65	648	45
66	658	46
67	668	47
68	678	48

Min.	4. D.	86. D.
69	688	48
70	698	49
71	708	50
72	718	50
73	728	51
74	738	52
75	748	52
76	758	53
77	768	54
78	778	55
79	788	55
80	798	56
81	808	57
82	818	57
83	828	58
84	838	59
85	848	59
86	858	60
87	868	61
88	878	61
89	888	62
90	898	63
91	908	63
92	918	64
93	928	65
94	938	66
95	948	66
96	958	67
97	968	68
98	978	68
99	988	69
100	998	70
200	1995	140
300	2993	209

M.	S.	D.	S.	D.	M.	S.	D.	S.	D.	M.	S.	D.	S.	D.
1	10		2		35	349	21	30	22	69	689	1		60
2	20		2		36	359	22	31		70	697	1		61
3	30		3		37	369	22	32		71	709	1		62
4	40		3		38	379	22	33		72	717	1		63
5	50		4		39	388	23	34	23	73	727	1		64
6	60		4		40	398	23	35	24	74	737	1		65
7	70		6		41	408	24	36	24	75	747	1		65
8	80		7		42	418	24	37	25	76	757	1		66
9	90		8		43	428	25	37	25	77	768	1		67
10	100		9		44	438	25	38	26	78	779	1		68
11	110		10		45	448	26	39	26	79	787	1		69
12	120		10		46	458	26	40	26	80	797	1		70
13	130		11		47	468	27	41	27	81	807	1		71
14	140		12		48	478	27	42	28	82	817	1		71
15	150		13		49	488	28	43	28	83	827	1		72
16	159		14		50	498	28	44	29	84	837	1		73
17	169		15		51	508	29	45	29	85	847	1		74
18	179		16		52	518	29	45	30	86	857	1		75
19	189		17		53	528	30	46	30	87	867	1		76
20	199		18		54	538	30	47	31	88	877	1		77
21	209		19		55	548	31	48	31	89	887	1		78
22	219		20		56	558	31	49	32	90	897	1		78
23	229		21		57	568	32	50	32	91	907	1		79
24	239		22		58	578	32	51	33	92	917	1		80
25	249		23		59	588	33	52	33	93	926	1		81
26	259		24		60	598	33	51	34	94	936	1		82
27	269		24		61	608	34	53	34	95	946	1		83
28	279		25		62	618	34	54	35	96	956	1		84
29	289		26		63	628	35	55	35	97	966	1		85
30	299		27		64	638	35	56	36	98	976	1		85
31	309		28		65	648	36	57	36	99	986	1		86
32	319		29		66	658	37	58	37	100	996	1		87
33	329		30		67	668	37	58	37	200	1992	3		174
34	339				68	677	38	59	38	300	2989	4		261

M.	6. D.	84. d.
1	10	1
2	20	2
3	30	3
4	40	4
5	50	5
6	60	6
7	70	7
8	80	8
9	89	9
10	99	10
11	109	11
12	119	12
13	129	14
14	139	15
15	149	16
16	159	17
17	169	18
18	179	19
19	189	20
20	199	21
21	209	22
22	219	23
23	229	24
24	239	25
25	249	26
26	259	27
27	268	28
28	278	29
29	288	30
30	298	31
31	308	32
32	318	33
33	328	34
34	338	35
35	348	36
36	358	38
37	368	39
38	378	40
39	388	41
40	398	42
41	408	43
42	418	44
43	428	45
44	438	46
45	447	47
46	457	48
47	467	49
48	477	50
49	487	51
50	497	52
51	507	53
52	517	54
53	527	55
54	537	56
55	547	57
56	557	58
57	567	59
58	577	61
59	587	62
60	597	63
61	607	64
62	617	65
63	627	66
64	637	67
65	646	68
66	656	69
67	666	70
68	676	71

Min.	6. D.	84. D.
69	686	72
70	696	73
71	706	74
72	716	75
73	726	76
74	736	77
75	746	78
76	756	79
77	766	80
78	776	81
79	786	82
80	796	83
81	806	85
82	815	86
83	825	87
84	835	88
85	845	89
86	855	90
87	865	91
88	875	92
89	885	93
90	895	94
91	905	95
92	915	96
93	925	97
94	935	98
95	945	99
96	955	100
97	965	101
98	975	102
99	985	103
100	995	104
200	1989	209
300	2983	313

M.	7. D.	83. d.	M.	7. D	83. d.	Min.	7. D.	83. D.
1	10	1	35	347	43	69	685	84
2	20	2	36	357	44	70	695	85
3	30	4	37	367	45	71	705	87
4	40	5	38	377	46	72	715	88
5	50	6	39	387	48	73	725	89
6	60	7	40	397	49	74	734	90
7	69	8	41	407	50	75	744	92
8	79	10	42	417	51	76	754	93
9	89	11	43	427	52	77	764	94
10	99	12	44	437	54	78	774	95
11	109	13	45	447	55	79	784	96
12	119	15	46	456	56	80	794	98
13	129	16	47	466	57	81	804	99
14	139	17	48	476	59	82	814	100
15	149	18	49	486	60	83	824	101
16	159	20	50	496	61	84	834	103
17	169	21	51	506	62	85	844	104
18	179	22	52	516	63	86	854	105
19	189	23	53	526	65	87	863	106
20	198	24	54	536	66	88	873	107
21	208	26	55	546	67	89	883	109
22	218	27	56	556	68	90	893	110
23	228	28	57	566	69	91	903	111
24	238	29	58	576	71	92	913	112
25	248	30	59	586	72	93	923	113
26	258	32	60	596	73	94	933	115
27	268	33	61	605	74	95	943	116
28	278	34	62	615	76	96	953	117
29	288	35	63	625	77	97	963	118
30	298	37	64	635	78	98	973	120
31	308	38	65	645	79	99	983	121
32	318	39	66	655	81	100	993	122
33	327	40	67	665	82	200	1985	244
34	337	41	68	675	83	300	2977	366

M.	S. D.	S. d.	M.	S. D.	S. d.	Min.	S. D.	S. D.
1	10	1	35	347	49	69	683	96
2	20	3	36	357	50	70	693	97
3	30	4	37	366	51	71	703	99
4	40	6	38	376	53	72	713	100
5	50	7	39	386	54	73	723	102
6	59	8	40	396	56	74	733	103
7	69	10	41	406	57	75	743	104
8	79	11	42	416	58	76	753	106
9	89	13	43	426	60	77	763	107
10	99	14	44	436	61	78	772	109
11	109	15	45	446	63	79	782	110
12	119	17	46	456	64	80	792	111
13	129	18	47	465	65	81	802	113
14	139	19	48	475	67	82	812	114
15	148	21	49	485	68	83	822	115
16	158	22	50	495	70	84	832	117
17	168	24	51	505	71	85	842	118
18	178	25	52	515	72	86	852	120
19	188	26	53	525	74	87	862	121
20	198	28	54	535	75	88	872	122
21	208	29	55	545	77	89	881	124
22	218	31	56	555	78	90	891	125
23	228	32	57	565	79	91	901	127
24	238	33	58	574	81	92	911	128
25	248	35	59	584	82	93	921	129
26	257	36	60	594	83	94	931	131
27	267	38	61	604	85	95	941	132
28	277	39	62	614	86	96	951	134
29	287	40	63	624	88	97	961	135
30	297	42	64	634	89	98	970	136
31	307	43	65	644	90	99	980	138
32	317	44	66	654	92	100	990	139
33	327	46	67	664	93	200	1981	278
34	337	47	68	693	95	300	2971	418

M.	9. D.	81. d.	M.	9. D.	81. d.	Min.	9. D.	81. D.
1	10	2	35	348	55	69	682	108
2	20	3	36	356	56	70	691	109
3	30	5	37	366	58	71	701	111
4	40	6	38	375	59	72	711	112
5	49	8	39	385	61	73	721	114
6	59	9	40	395	63	74	731	116
7	69	11	41	405	64	75	741	117
8	79	13	42	415	66	76	751	119
9	89	14	43	425	67	77	761	120
10	99	16	44	435	69	78	770	122
11	109	17	45	445	70	79	780	124
12	119	19	46	454	72	80	790	125
13	129	20	47	464	73	81	800	127
14	138	22	48	474	75	82	810	128
15	148	23	49	484	77	83	820	130
16	158	25	50	494	78	84	830	131
17	168	26	51	504	80	85	840	133
18	178	28	52	514	81	86	850	134
19	188	30	53	524	83	87	859	136
20	198	31	54	534	84	88	869	138
21	208	33	55	543	86	89	879	139
22	217	34	56	553	88	90	889	141
23	227	36	57	563	89	91	899	142
24	237	37	58	573	91	92	909	144
25	247	39	59	583	92	93	919	145
26	257	41	60	593	94	94	929	147
27	267	42	61	603	95	95	938	148
28	277	44	62	612	97	96	948	150
29	287	45	63	622	98	97	958	152
30	296	47	64	632	100	98	968	153
31	306	48	65	641	102	99	978	155
32	316	50	66	652	103	100	988	156
33	326	51	67	662	105	200	1975	213
34	336	53	68	672	106	300	2963	369

M.	10. d.	80. d.
1	10	2
2	20	3
3	30	5
4	39	7
5	49	9
6	59	10
7	69	12
8	79	14
9	89	16
10	99	17
11	108	19
12	118	21
13	128	23
14	138	24
15	148	26
16	158	28
17	168	30
18	177	31
19	187	33
20	197	35
21	207	36
22	217	38
23	227	40
24	236	42
25	246	43
26	256	45
27	266	47
28	276	49
29	286	50
30	296	52
31	305	54
32	315	55
33	325	57
34	333	59
35	345	61
36	355	62
37	365	64
38	374	66
39	384	68
40	394	69
41	404	71
42	414	73
43	424	75
44	433	76
45	443	78
46	453	80
47	463	81
48	473	83
49	483	85
50	492	87
51	502	88
52	512	90
53	522	92
54	532	94
55	542	95
56	552	97
57	561	99
58	571	101
59	581	102
60	591	104
61	601	106
62	611	108
63	620	109
64	630	111
65	640	113
66	650	115
67	660	116
68	670	118

Min.	10. D.	80. D.
69	680	120
70	689	121
71	699	123
72	709	125
73	719	127
74	729	128
75	739	130
76	749	132
77	758	133
78	768	135
79	778	137
80	788	139
81	798	141
82	808	142
83	817	144
84	827	146
85	837	148
86	847	149
87	857	151
88	867	153
89	876	154
90	886	156
91	896	158
92	906	160
93	916	161
94	926	163
95	936	165
96	946	167
97	955	168
98	965	170
99	975	172
100	985	174
200	1970	347
300	2954	521

M.	11. d.	79. d.	M.	11. d.	79. d.	Min	11. D.	79. D.
1	10	2	35	343	67	69	677	132
2	20	4	36	353	69	70	687	134
3	29	6	37	363	71	71	697	135
4	39	8	38	373	72	72	707	137
5	49	9	39	383	74	73	716	139
6	59	11	40	393	76	74	726	141
7	69	13	41	402	78	75	736	143
8	78	15	42	412	80	76	746	145
9	88	17	43	422	82	77	756	147
10	98	19	44	432	84	78	765	149
11	108	21	45	442	86	79	775	151
12	118	23	46	452	88	80	785	153
13	128	25	47	461	90	81	795	154
14	137	27	48	471	92	82	805	156
15	147	29	49	481	93	83	815	158
16	157	30	50	491	95	84	824	160
17	167	32	51	501	97	85	834	162
18	177	34	52	510	99	86	844	164
19	186	36	53	520	101	87	854	166
20	196	38	54	530	103	88	864	168
21	206	40	55	540	105	89	873	170
22	216	42	56	550	107	90	883	172
23	226	44	57	559	109	91	893	174
24	236	46	58	569	111	92	903	176
25	245	48	59	579	112	93	913	177
26	255	50	60	589	114	94	923	179
27	265	51	61	599	116	95	932	181
28	275	53	62	609	118	96	942	183
29	285	55	63	618	120	97	952	185
30	294	57	64	628	122	98	962	187
31	304	59	65	638	124	99	972	189
32	314	61	66	648	126	100	981	191
33	324	63	67	658	128	200	1963	382
34	334	65	68	668	130	300	2944	572

M.	12. d.	78. d.	M.	12. d.	78. d.	Min.	12. D.	78. D.
1	10	2	35	342	73	69	675	144
2	20	4	36	352	75	70	685	146
3	29	6	37	362	77	71	694	148
4	39	8	38	372	79	72	704	150
5	49	10	39	381	81	73	714	152
6	59	12	40	391	83	74	724	154
7	68	15	41	401	85	75	734	156
8	78	17	42	411	87	76	743	158
9	88	19	43	420	90	77	753	160
10	98	21	44	430	92	78	763	162
11	108	23	45	440	94	79	773	164
12	117	25	46	450	96	80	783	166
13	127	27	47	460	98	81	792	168
14	137	29	48	470	010	82	802	170
15	147	31	49	479	102	83	812	173
16	156	33	50	489	104	84	822	175
17	166	36	51	499	106	85	831	177
18	176	38	52	509	108	86	841	179
19	186	40	53	518	110	87	851	181
20	196	42	54	528	112	88	861	183
21	205	44	55	538	114	89	871	185
22	215	46	56	548	116	90	880	187
23	225	48	57	558	118	91	890	189
24	235	50	58	567	121	92	900	191
25	245	52	59	577	123	93	910	193
26	254	54	60	587	125	94	920	195
27	264	56	61	597	127	95	929	197
28	274	58	62	607	129	96	939	200
29	284	60	63	616	131	97	949	202
30	293	62	64	626	133	98	959	204
31	303	64	65	636	135	99	968	206
32	313	66	66	646	137	100	978	208
33	323	69	67	655	140	200	1956	416
34	333	71	68	665	142	300	2934	624

M.	13. d.	77. d.
1	10	2
2	20	4
3	29	7
4	39	9
5	49	11
6	59	13
7	68	16
8	78	18
9	88	20
10	98	22
11	107	25
12	117	27
13	127	29
14	136	31
15	146	34
16	156	36
17	166	38
18	176	40
19	185	43
20	195	45
21	205	47
22	215	49
23	224	52
24	234	54
25	244	56
26	254	58
27	263	61
28	273	63
29	283	65
30	292	67
31	302	70
32	312	72
33	322	74
34	331	76

M.	13. d.	77. d.
35	341	79
36	351	81
37	361	83
38	370	86
39	380	88
40	390	90
41	400	92
42	409	94
43	419	97
44	429	99
45	438	101
46	448	103
47	458	106
48	468	108
49	477	110
50	487	112
51	497	115
52	507	117
53	516	119
54	526	121
55	536	124
56	546	126
57	555	128
58	565	130
59	575	133
60	585	135
61	594	137
62	604	140
63	614	142
64	624	144
65	634	146
66	643	148
67	653	151
68	663	153

Min.	13. D.	77. D.
69	672	155
70	682	157
71	692	160
72	702	162
73	711	164
74	721	166
75	731	169
76	741	171
77	750	173
78	760	175
79	770	178
80	780	180
81	789	182
82	799	184
83	809	187
84	818	189
85	828	191
86	838	193
87	848	196
88	857	198
89	867	200
90	877	202
91	887	205
92	896	207
93	906	209
94	916	211
95	926	214
96	935	216
97	945	218
98	955	221
99	965	223
100	974	225
200	1949	450
300	2923	675

M.	41. d.	76. d.
1	10	2
2	19	5
3	29	7
4	39	10
5	48	12
6	58	14
7	68	17
8	78	19
9	87	22
10	97	24
11	107	27
12	116	29
13	126	31
14	136	34
15	146	36
16	155	39
17	165	41
18	175	44
19	184	46
20	194	48
21	204	51
22	213	53
23	223	56
24	233	58
25	242	60
26	252	63
27	262	65
28	272	68
29	281	70
30	291	73
31	301	75
32	310	77
33	320	80
34	330	82

M.	14. d.	76. d.
35	340	85
36	349	87
37	359	90
38	369	92
39	378	94
40	388	97
41	398	99
42	407	102
43	417	104
44	427	107
45	437	109
46	446	111
47	456	114
48	466	116
49	475	119
50	485	121
51	495	123
52	504	126
53	514	128
54	524	131
55	534	133
56	543	136
57	553	138
58	563	140
59	572	143
60	582	145
61	592	148
62	601	150
63	611	153
64	621	155
65	631	157
66	640	160
67	650	162
68	660	165

Min.	14. D.	76. D.
69	669	167
70	679	169
71	689	172
72	698	174
73	708	177
74	718	179
75	728	182
76	737	184
77	747	187
78	757	189
79	766	191
80	776	194
81	786	195
82	796	197
83	805	200
84	815	202
85	825	205
86	834	207
87	844	209
88	854	213
89	864	215
90	873	218
91	883	220
92	893	223
93	902	225
94	912	227
95	921	230
96	931	232
97	941	235
98	951	237
99	960	240
100	970	242
200	1941	484
300	2911	726

M.	15.d.	75.d.	M.	15.d	75.d.	Min.	15.D.	75.D.
1	10	3	35	338	91	69	666	179
2	19	5	36	348	93	70	676	181
3	29	8	37	357	96	71	686	184
4	39	10	38	367	98	72	696	186
5	48	13	39	377	101	73	705	189
6	58	16	40	386	103	74	715	192
7	68	18	41	396	106	75	724	194
8	77	21	42	406	109	76	734	197
9	87	23	43	415	111	77	744	200
10	97	26	44	425	114	78	754	202
11	106	28	45	435	116	79	763	205
12	116	31	46	444	119	80	773	207
13	126	34	47	454	123	81	783	210
14	135	36	48	464	125	82	792	212
15	145	39	49	473	128	83	802	215
16	155	41	50	483	129	84	811	217
17	164	44	51	493	132	85	821	220
18	174	47	52	502	135	86	831	223
19	183	49	53	512	137	87	840	225
20	193	52	54	522	140	88	850	228
21	203	54	55	531	142	89	860	230
22	213	57	56	541	145	90	869	233
23	222	60	57	551	148	91	879	236
24	232	62	58	560	150	92	889	238
25	242	65	59	570	153	93	898	241
26	251	67	60	580	155	94	908	243
27	261	70	61	589	158	95	918	246
28	271	73	62	599	160	96	927	248
29	280	75	63	608	163	97	937	251
30	290	78	64	618	166	98	947	254
31	299	80	65	628	168	99	956	256
32	309	83	66	638	171	100	966	259
33	319	85	67	647	174	200	1932	518
34	328	88	68	657	176	300	2898	776

M.	16. d.	74. d.
1	10	3
2	19	6
3	29	8
4	38	11
5	48	14
6	58	17
7	67	19
8	77	22
9	86	25
10	96	28
11	106	30
12	115	33
13	125	36
14	134	39
15	144	41
16	154	44
17	163	47
18	173	50
19	183	53
20	192	55
21	202	58
22	211	61
23	221	63
24	231	66
25	240	69
26	250	72
27	259	75
28	269	77
29	279	80
30	288	83
31	298	85
32	308	88
33	317	91
34	327	94

M.	16. d.	74. d.
35	336	97
36	346	99
37	356	102
38	365	105
39	375	107
40	384	110
41	394	113
42	404	116
43	413	119
44	423	121
45	432	124
46	442	127
47	452	130
48	461	132
49	471	135
50	481	138
51	490	141
52	500	143
53	509	146
54	519	149
55	529	151
56	538	154
57	548	157
58	557	160
59	567	163
60	577	165
61	586	168
62	596	171
63	606	174
64	615	177
65	625	179
66	634	182
67	644	185
68	654	188

Min.	16. D.	74. D.
69	663	190
70	673	193
71	682	196
72	692	199
73	702	201
74	711	204
75	721	207
76	731	210
77	740	213
78	750	215
79	759	218
80	769	220
81	778	223
82	788	226
83	798	229
84	807	232
85	817	235
86	827	237
87	836	240
88	846	243
89	856	245
90	865	248
91	875	251
92	884	254
93	894	257
94	904	259
95	913	262
96	923	265
97	932	267
98	942	270
99	952	273
100	961	276
200	1923	551
300	2884	827

M.	17.d.	73.d.
1	10	3
2	19	6
3	29	9
4	38	12
5	48	15
6	57	17
7	67	20
8	76	23
9	86	26
10	96	29
11	105	32
12	115	35
13	124	38
14	134	41
15	143	44
16	153	47
17	162	50
18	172	52
19	182	55
20	191	58
21	201	61
22	210	64
23	220	67
24	230	70
25	239	73
26	249	76
27	258	79
28	268	82
29	277	85
30	287	88
31	296	91
32	306	93
33	316	96
34	325	99
35	335	102
36	344	105
37	354	108
38	363	111
39	373	114
40	383	117
41	392	120
42	402	123
43	411	126
44	421	129
45	430	131
46	440	134
47	449	137
48	459	140
49	469	143
50	478	146
51	488	149
52	497	152
53	507	155
54	516	158
55	526	161
56	535	164
57	545	167
58	554	170
59	564	172
60	574	175
61	583	178
62	593	181
63	602	184
64	612	187
65	622	190
66	631	193
67	641	196
68	650	199

Min.	17.D.	73.D.
69	660	202
70	669	205
71	679	207
72	688	210
73	698	213
74	708	216
75	717	219
76	727	222
77	736	225
78	746	228
79	755	231
80	765	234
81	775	237
82	784	240
83	794	243
84	803	246
85	813	248
86	822	251
87	832	254
88	842	257
89	851	260
90	861	263
91	870	266
92	880	269
93	889	272
94	899	275
95	908	278
96	918	281
97	928	284
98	937	287
99	947	289
100	956	292
200	1913	585
300	2869	877

M.	18. d.	72. d.
1	10	3
2	19	6
3	28	9
4	38	12
5	47	15
6	57	18
7	66	22
8	76	25
9	85	28
10	95	31
11	104	34
12	114	37
13	123	40
14	133	43
15	142	46
16	152	50
17	161	53
18	171	56
19	180	59
20	190	62
21	200	65
22	209	68
23	219	71
24	228	74
25	238	77
26	247	81
27	257	84
28	266	87
29	276	90
30	285	93
31	295	96
32	304	99
33	314	102
34	323	105
35	333	108
36	342	111
37	352	114
38	361	117
39	371	120
40	380	123
41	390	127
42	398	130
43	408	133
44	417	136
45	427	139
46	436	142
47	446	145
48	455	148
49	465	151
50	475	154
51	485	158
52	495	161
53	504	164
54	514	167
55	523	170
56	533	173
57	542	176
58	552	179
59	561	182
60	571	185
61	580	188
62	590	192
63	599	195
64	609	198
65	618	201
66	628	204
67	637	207
68	647	210

Min.	18. D.	72. D.
69	656	213
70	666	216
71	675	219
72	685	222
73	694	225
74	704	229
75	713	232
76	723	235
77	732	238
78	742	241
79	751	244
80	761	247
81	770	250
82	780	253
83	789	256
84	799	260
85	808	263
86	818	266
87	827	269
88	837	272
89	846	275
90	856	278
91	865	281
92	875	284
93	884	287
94	894	290
95	903	293
96	913	297
97	922	300
98	932	303
99	941	306
100	951	309
200	1902	618
300	2853	927

M.	19. d.	71. d.
1	9	3
2	19	6
3	28	10
4	38	13
5	47	16
6	57	20
7	66	23
8	75	26
9	85	29
10	94	33
11	104	36
12	113	39
13	123	42
14	132	46
15	142	49
16	151	52
17	161	55
18	170	59
19	180	62
20	189	65
21	199	68
22	208	72
23	217	75
24	227	78
25	236	82
26	246	85
27	255	88
28	265	91
29	274	94
30	284	98
31	293	101
32	303	104
33	312	107
34	321	111
35	331	114
36	340	117
37	350	121
38	359	124
39	369	127
40	378	130
41	388	134
42	397	137
43	407	140
44	416	143
45	425	147
46	435	150
47	444	153
48	454	156
49	463	160
50	473	163
51	482	166
52	492	169
53	501	173
54	510	176
55	520	179
56	529	182
57	539	186
58	548	189
59	558	192
60	567	195
61	577	199
62	586	202
63	596	205
64	605	208
65	615	212
66	624	215
67	634	218
68	643	222

Min.	19. D.	71. D.
69	652	225
70	662	228
71	671	231
72	681	234
73	690	238
74	699	241
75	709	244
76	718	247
77	728	251
78	737	254
79	747	257
80	756	261
81	766	264
82	775	267
83	785	270
84	794	274
85	804	277
86	813	280
87	822	283
88	832	287
89	841	290
90	851	293
91	860	296
92	870	300
93	879	303
94	889	306
95	898	309
96	908	313
97	917	316
98	926	313
99	936	322
100	945	326
200	1891	651
300	2836	977

M.	10. d.	70. d.	M.	20. d.	70. d.	Min.	20. D.	70 D.
1	9	3	35	329	120	69	648	236
2	19	7	36	338	123	70	658	239
3	28	10	37	348	126	71	667	243
4	38	14	38	357	130	72	677	246
5	47	17	39	366	133	73	686	250
6	56	20	40	376	137	74	695	253
7	66	24	41	385	140	75	705	256
8	75	27	42	395	144	76	714	260
9	85	31	43	404	447	77	724	263
10	94	34	44	413	150	78	733	267
11	103	38	45	423	154	79	742	270
12	113	41	46	432	157	80	752	274
13	122	44	47	442	161	81	761	277
14	132	48	48	451	164	82	771	280
15	141	51	49	460	168	83	780	284
16	150	55	50	470	171	84	789	287
17	160	58	51	479	174	85	800	291
18	169	61	52	489	178	86	808	294
19	179	65	53	498	181	87	818	298
20	188	68	54	507	185	88	827	301
21	197	72	55	517	188	89	836	304
22	207	75	56	526	191	90	846	308
23	216	79	57	536	195	91	855	311
24	226	82	58	545	198	92	864	315
25	235	85	59	554	202	93	874	318
26	244	89	60	564	205	94	883	321
27	254	92	61	573	209	95	893	325
28	263	96	62	583	212	96	902	328
29	272	100	63	592	215	97	912	332
30	282	103	64	601	119	98	921	335
31	291	106	65	611	222	99	930	339
32	301	109	66	620	226	100	940	342
33	310	113	67	630	229	200	1879	684
34	319	116	68	639	233	300	2819	1026

M.	21. d.	69. d.	M.	21. d.	69. d.	Min.	21. D.	69. D.
1	9	4	35	327	125	69	644	247
2	19	7	36	336	129	70	653	251
3	28	11	37	345	132	71	663	254
4	37	14	38	355	136	72	672	258
5	47	18	39	364	140	73	681	262
6	56	21	40	373	143	74	691	265
7	65	25	41	383	147	75	700	269
8	75	29	42	392	150	76	709	272
9	84	32	43	401	154	77	719	276
10	93	36	44	411	158	78	728	279
11	103	39	45	420	161	79	737	283
12	112	43	46	429	165	80	747	287
13	121	47	47	439	168	81	756	290
14	131	50	48	448	172	82	766	294
15	140	54	49	457	176	83	775	297
16	149	57	50	467	179	84	784	301
17	159	61	51	476	183	85	794	305
18	168	64	52	485	186	86	803	308
19	177	168	53	495	190	87	812	312
20	187	72	54	504	193	88	822	315
21	196	75	55	513	197	89	831	319
22	205	79	56	523	201	90	840	323
23	215	82	57	532	204	91	849	326
24	224	86	58	541	208	92	859	330
25	233	90	59	551	211	93	868	333
26	243	93	60	560	215	94	877	337
27	252	97	61	569	219	95	887	340
28	261	100	62	579	222	96	896	344
29	271	104	63	588	226	97	905	348
30	280	107	64	598	229	98	915	351
31	289	111	65	607	233	99	924	355
32	299	115	66	616	236	100	934	358
33	308	118	67	626	240	200	1867	717
34	317	122	68	635	244	300	1801	1075

M.	22.d.	68. d.
1	9	4
2	19	7
3	28	11
4	37	15
5	46	19
6	56	22
7	65	26
8	74	30
9	83	34
10	93	37
11	102	41
12	111	45
13	120	49
14	130	52
15	139	56
16	148	60
17	157	64
18	167	67
19	176	71
20	185	75
21	195	79
22	204	82
23	213	86
24	222	90
25	232	94
26	241	97
27	250	101
28	260	105
29	269	109
30	278	112
31	287	116
32	297	120
33	306	124
34	315	127

M.	22. d.	68 d.
35	324	131
36	334	135
37	343	139
38	352	142
39	361	146
40	371	150
41	380	154
42	389	157
43	399	161
44	408	165
45	417	169
46	426	172
47	436	176
48	445	180
49	454	184
50	464	187
51	473	191
52	482	195
53	491	199
54	501	202
55	510	206
56	519	210
57	529	214
58	538	217
59	547	221
60	556	225
61	566	229
62	575	232
63	584	236
64	594	240
65	603	244
66	612	247
67	621	251
68	631	255

Min.	22.D.	68.D.
69	640	259
70	649	262
71	658	266
72	667	270
73	677	274
74	686	277
75	695	281
76	705	285
77	714	289
78	723	292
79	733	296
80	742	300
81	751	304
82	760	307
83	770	311
84	779	315
85	788	319
86	797	322
87	806	326
88	816	330
89	825	334
90	834	337
91	844	342
92	853	345
93	862	349
94	871	352
95	881	356
96	890	360
97	899	364
98	909	367
99	918	371
100	927	375
200	1854	749
300	2782	1094

M.	23. d.	67. d.
1	9	4
2	18	8
3	28	12
4	37	16
5	46	19
6	55	23
7	64	27
8	74	31
9	83	35
10	92	39
11	101	43
12	110	47
13	120	51
14	129	55
15	138	59
16	147	62
17	156	66
18	166	70
19	175	74
20	184	78
21	193	82
22	202	86
23	212	90
24	221	94
25	230	98
26	239	102
27	248	105
28	258	109
29	267	113
30	276	117
31	285	121
32	294	125
33	304	129
34	313	133

M.	23. d	67. d.
35	322	137
36	331	141
37	340	144
38	350	148
39	359	152
40	368	156
41	377	160
42	386	164
43	396	168
44	405	172
45	414	176
46	423	180
47	433	184
48	442	187
49	451	191
50	460	195
51	469	199
52	479	203
53	488	207
54	497	211
55	506	215
56	515	219
57	524	223
58	534	226
59	543	230
60	552	234
61	561	238
62	571	242
63	580	246
64	589	250
65	598	254
66	608	258
67	618	262
68	626	266

Min.	23. D.	67. D.
69	635	269
70	644	273
71	653	277
72	663	281
73	672	285
74	681	289
75	690	293
76	699	297
77	709	301
78	718	305
79	727	308
80	736	312
81	746	316
82	755	320
83	764	324
84	773	328
85	782	332
86	792	336
87	801	340
88	810	344
89	819	348
90	828	352
91	838	356
92	847	360
93	856	363
94	865	367
95	874	370
96	884	375
97	893	379
98	902	383
99	911	387
100	920	391
200	1841	781
300	2761	1172

M.	24.d.	66.d.	M.	24.d.	66 d.	Min.	24.D.	66.D.
1	9	4	35	320	142	69	630	281
2	18	8	36	329	146	70	639	285
3	27	12	37	338	151	71	648	289
4	36	16	38	347	155	72	658	293
5	46	20	39	356	159	73	667	297
6	55	24	40	365	163	74	676	301
7	64	28	41	374	167	75	685	305
8	73	32	42	384	171	76	694	309
9	82	37	43	393	175	77	703	313
10	91	41	44	402	179	78	712	317
11	100	45	45	411	183	79	721	321
12	109	49	46	420	187	80	731	325
13	119	53	47	429	191	81	740	329
14	128	57	48	438	195	82	749	333
15	137	61	49	448	199	83	758	337
16	146	65	50	457	203	84	767	341
17	155	69	51	466	207	85	776	345
18	164	73	52	475	211	86	785	349
19	173	77	53	484	216	87	795	353
20	183	81	54	493	220	88	804	357
21	192	85	55	502	224	89	813	362
22	201	90	56	511	228	90	822	366
23	210	94	57	521	232	91	831	370
24	219	98	58	530	236	92	840	374
25	228	102	59	539	240	93	849	378
26	237	106	60	548	244	94	858	382
27	246	110	61	557	248	95	868	386
28	256	113	62	566	252	96	877	390
29	265	117	63	575	256	97	886	395
30	274	122	64	585	260	98	895	399
31	283	126	65	594	264	99	904	403
32	292	130	66	603	268	100	913	407
33	301	134	67	612	272	200	1827	813
34	310	138	68	621	276	300	2740	1220

M.	25. d.	65. d.	M.	25. d	65. d.	Min.	25. D.	65. D.
1	9	4	35	317	148	69	625	292
2	18	8	36	326	152	70	634	296
3	27	13	37	335	156	71	643	300
4	36	17	38	344	161	72	652	305
5	45	21	39	353	165	73	662	309
6	54	25	40	362	169	74	671	313
7	63	30	41	372	173	75	680	317
8	72	34	42	381	178	76	689	321
9	81	38	43	390	182	77	698	326
10	91	42	44	399	186	78	707	330
11	100	47	45	408	190	79	716	334
12	109	51	46	417	195	80	725	338
13	118	55	47	426	199	81	734	343
14	127	59	48	435	203	82	743	347
15	136	63	49	444	207	83	752	351
16	145	68	50	453	211	84	761	355
17	154	72	51	462	216	85	770	360
18	163	76	52	471	220	86	779	364
19	172	80	53	480	224	87	788	268
20	181	84	54	489	228	88	797	372
21	190	89	55	498	232	89	807	376
22	199	93	56	507	237	90	816	380
23	208	97	57	516	241	91	825	384
24	218	101	58	526	245	92	834	389
25	227	106	59	535	250	93	843	393
26	236	110	60	544	254	94	852	397
27	245	114	61	553	258	95	861	401
28	254	118	62	562	262	96	870	406
29	263	123	63	571	267	97	879	410
30	272	127	64	580	271	98	888	414
31	281	131	65	589	275	99	897	418
32	290	135	66	598	279	100	906	423
33	299	140	67	607	283	200	1813	845
34	308	144	68	616	288	300	2719	1268

M.	26. d.	64. d.	M.	26. d.	64. d.	Min.	26. D.	64. D.
1	9	4	35	315	158	69	620	302
2	18	9	36	324	158	70	629	307
3	27	13	37	333	162	71	638	311
4	36	18	38	342	166	72	647	316
5	45	22	39	351	171	73	656	320
6	54	26	40	360	175	74	665	324
7	63	31	41	368	179	75	674	329
8	72	35	42	378	184	76	683	333
9	81	39	43	386	188	77	692	338
10	90	44	44	395	193	78	701	342
11	99	48	45	404	197	79	710	346
12	108	53	46	413	202	80	719	351
13	117	57	47	422	206	81	728	355
14	126	61	48	431	210	82	737	359
15	135	66	49	440	214	83	746	364
16	144	70	50	449	219	84	755	368
17	153	74	51	458	225	85	764	372
18	162	79	52	467	228	86	773	377
19	171	83	53	476	232	87	782	381
20	180	88	54	485	237	88	791	385
21	189	92	55	494	241	89	800	390
22	198	96	56	503	245	90	809	394
23	207	101	57	512	250	91	818	399
24	216	105	58	521	254	92	827	403
25	225	109	59	530	258	93	836	407
26	234	114	60	539	263	94	845	412
27	243	118	61	548	267	95	854	416
28	252	123	62	557	272	96	863	421
29	261	127	63	566	276	97	872	425
30	270	131	64	575	280	98	881	429
31	279	136	65	584	285	99	890	434
32	288	140	66	593	289	100	899	438
33	297	144	67	602	294	200	1798	877
34	306	149	68	611	298	300	2696	1315

M.	27. d.	63. d.	M.	27. d.	63. d.	Min.	27. D.	63. D.
1	9	5	35	312	159	69	615	313
2	18	9	36	321	163	70	624	318
3	27	14	37	330	168	71	633	322
4	36	18	38	338	172	72	641	327
5	45	23	39	347	177	73	650	332
6	53	27	40	356	182	74	659	336
7	62	32	41	365	186	75	668	341
8	71	36	42	374	191	76	677	345
9	80	41	43	383	195	77	686	350
10	89	45	44	391	200	78	695	354
11	98	50	45	401	204	79	704	359
12	107	54	46	410	209	80	713	363
13	116	59	47	419	213	81	722	368
14	125	63	48	428	218	82	731	372
15	134	68	49	436	222	83	739	377
16	143	72	50	445	227	84	748	381
17	151	77	51	454	232	85	757	386
18	160	82	52	463	236	86	766	390
19	169	86	53	472	241	87	775	395
20	178	91	54	481	245	88	784	400
21	187	95	55	490	250	89	793	404
22	196	100	56	499	254	90	802	409
23	205	104	57	508	259	91	811	413
24	214	109	58	517	263	92	820	418
25	223	113	59	526	268	93	829	422
26	232	118	60	535	272	94	837	427
27	241	122	61	543	277	95	846	431
28	249	127	62	552	282	96	855	436
29	258	132	63	561	286	97	864	440
30	267	136	64	570	291	98	873	445
31	276	141	65	579	295	99	882	449
32	285	145	66	588	300	100	891	454
33	294	150	67	597	304	200	1782	909
34	303	154	68	606	309	300	2673	1363

M.	28. d.	62. d.
1	9	5
2	18	9
3	26	14
4	35	19
5	44	23
6	53	28
7	62	33
8	71	37
9	79	42
10	88	47
11	97	52
12	106	56
13	115	61
14	124	66
15	132	70
16	141	75
17	150	80
18	159	84
19	168	89
20	177	94
21	185	99
22	194	103
23	203	108
24	212	113
25	221	117
26	230	122
27	238	127
28	247	131
29	256	136
30	265	141
31	274	145
32	282	150
33	291	155
34	300	160

M.	28. d.	62. d.
35	309	164
36	318	169
37	326	174
38	335	178
39	344	183
40	353	188
41	362	192
42	371	197
43	380	202
44	388	207
45	397	211
46	406	216
47	415	221
48	424	225
49	432	230
50	441	235
51	450	239
52	459	244
53	468	249
54	477	254
55	485	258
56	494	263
57	503	268
58	512	272
59	521	277
60	530	282
61	538	286
62	547	291
63	556	296
64	565	300
65	574	305
66	583	310
67	591	315
68	600	319

Min.	28. D.	62. D.
69	609	324
70	618	329
71	627	333
72	636	338
73	644	343
74	653	347
75	662	352
76	671	357
77	680	361
78	689	366
79	697	371
80	706	376
81	715	380
82	724	385
83	733	390
84	742	394
85	750	399
86	759	404
87	768	408
88	777	413
89	786	418
90	795	422
91	803	427
92	812	432
93	821	437
94	830	441
95	839	446
96	848	451
97	856	455
98	865	460
99	874	465
100	883	469
200	1766	939
300	2649	1408

M.	29. d.	61. d.
1	9	5
2	17	10
3	26	14
4	35	19
5	44	24
6	52	29
7	61	34
8	70	39
9	79	43
10	87	48
11	96	53
12	105	58
13	114	63
14	122	68
15	131	73
16	140	77
17	149	82
18	157	87
19	166	92
20	175	97
21	184	102
22	192	107
23	201	111
24	210	116
25	219	121
26	227	126
27	236	131
28	245	136
29	254	141
30	262	145
31	271	150
32	280	155
33	289	160
34	297	165

M.	29. d.	61. d.
35	306	170
36	315	174
37	324	179
38	332	184
39	341	189
40	350	194
41	359	199
42	367	203
43	376	208
44	385	213
45	394	218
46	402	223
47	411	228
48	420	233
49	429	237
50	437	242
51	446	247
52	455	252
53	464	257
54	472	262
55	481	267
56	490	271
57	499	276
58	507	281
59	516	286
60	525	291
61	534	296
62	542	301
63	551	305
64	560	310
65	569	315
66	577	320
67	586	325
68	595	330

Min.	29. D.	61. D.
69	604	334
70	612	339
71	621	344
72	630	349
73	638	354
74	647	359
75	656	363
76	665	368
77	673	373
78	682	378
79	691	383
80	700	388
81	708	393
82	717	397
83	726	402
84	735	407
85	743	412
86	752	417
87	761	422
88	770	427
89	778	431
90	787	436
91	796	441
92	805	446
93	813	451
94	822	456
95	831	461
96	840	465
97	848	470
98	857	475
99	866	480
100	875	485
200	1749	970
300	2624	1454

M.	30. d.	60. d.
1	9	5
2	17	10
3	26	15
4	35	20
5	43	25
6	52	30
7	61	35
8	69	40
9	78	45
10	87	50
11	95	55
12	104	60
13	113	65
14	121	70
15	130	75
16	139	80
17	147	85
18	156	90
19	165	95
20	173	100
21	182	105
22	191	110
23	199	115
24	208	120
25	217	125
26	225	130
27	234	135
28	242	140
29	251	145
30	260	150
31	268	155
32	277	160
33	286	165
34	294	170

M.	30. d.	60 d.
35	303	175
36	312	180
37	320	185
38	329	190
39	338	195
40	346	200
41	355	205
42	364	210
43	372	215
44	381	220
45	390	225
46	398	230
47	407	235
48	416	240
49	424	245
50	433	250
51	442	255
52	450	260
53	459	265
54	468	270
55	476	275
56	485	280
57	494	285
58	502	290
59	511	295
60	520	300
61	528	305
62	537	310
63	546	315
64	554	320
65	563	325
66	572	330
67	580	335
68	589	340

Min.	30. D.	60 D.
69	598	345
70	606	350
71	615	355
72	623	360
73	632	365
74	641	370
75	649	375
76	658	380
77	667	385
78	676	390
79	684	395
80	693	400
81	702	405
82	710	410
83	719	415
84	727	420
85	736	425
86	745	430
87	753	435
88	762	440
89	771	445
90	779	450
91	788	455
92	797	460
93	806	465
94	814	470
95	823	475
96	832	480
97	840	485
98	849	490
99	857	495
100	866	500
200	1732	1000
300	2598	1500

M.	31. d.	59. d.	M.	31. d	59. d.	Min.	31. D.	59. D.
1	9	5	35	300	180	69	591	355
2	17	10	36	309	185	70	600	360
3	26	15	37	317	191	71	609	366
4	34	21	38	326	196	72	617	371
5	43	26	39	334	201	73	626	376
6	51	31	40	343	206	74	634	381
7	60	36	41	351	211	75	643	386
8	69	41	42	360	216	76	651	391
9	77	46	43	369	221	77	660	397
10	86	51	44	377	227	78	669	402
11	94	57	45	386	232	79	677	407
12	103	62	46	394	237	80	686	412
13	111	67	47	403	242	81	694	417
14	120	72	48	411	247	82	703	422
15	129	77	49	420	252	83	711	427
16	137	82	50	429	257	84	720	433
17	146	88	51	437	263	85	729	438
18	154	93	52	446	268	86	737	443
19	163	98	53	454	273	87	746	448
20	171	103	54	463	278	88	754	453
21	180	108	55	471	283	89	763	458
22	189	113	56	480	288	90	771	463
23	197	118	57	489	294	91	780	469
24	206	124	58	497	299	92	789	474
25	214	129	59	506	304	93	797	479
26	223	134	60	514	309	94	806	484
27	231	139	61	523	314	95	814	489
28	240	144	62	531	319	96	823	494
29	249	149	63	540	324	97	831	500
30	257	154	64	549	330	98	840	505
31	266	160	65	557	335	99	849	510
32	274	165	66	566	340	100	857	515
33	283	170	67	574	345	200	1714	1030
34	292	175	68	583	350	300	2572	1545

M.	32. d.	58. d.
1	8	5
2	17	11
3	25	16
4	34	21
5	42	26
6	51	32
7	59	37
8	68	42
9	76	48
10	85	53
11	93	58
12	102	64
13	110	69
14	119	74
15	127	79
16	136	85
17	144	90
18	153	95
19	161	101
20	170	106
21	178	111
22	187	117
23	195	122
24	204	127
25	212	132
26	220	138
27	229	143
28	237	148
29	246	153
30	254	159
31	263	164
32	271	170
33	280	175
34	288	180
35	297	185
36	305	191
37	314	196
38	322	201
39	331	207
40	339	212
41	348	217
42	356	223
43	365	228
44	373	233
45	382	238
46	390	244
47	398	249
48	407	254
49	415	260
50	424	265
51	432	270
52	441	275
53	449	281
54	458	286
55	466	291
56	475	297
57	483	302
58	492	307
59	500	313
60	509	318
61	517	323
62	526	329
63	534	334
64	543	339
65	551	344
66	560	350
67	568	355
68	577	360

Min.	32. D.	58. D.
69	585	366
70	594	371
71	602	376
72	610	381
73	619	387
74	627	392
75	636	397
76	644	403
77	653	408
78	661	413
79	670	419
80	678	424
81	687	429
82	695	434
83	703	440
84	712	445
85	721	450
86	729	456
87	738	461
88	746	466
89	755	472
90	763	477
91	772	482
92	780	487
93	788	493
94	797	498
95	805	503
96	814	509
97	822	514
98	831	519
99	839	524
100	848	530
200	1696	1060
300	2544	1590

M.	33. d	57. d
1	8	5
2	17	11
3	25	16
4	34	22
5	42	27
6	50	33
7	59	38
8	67	44
9	76	49
10	84	54
11	92	60
12	101	65
13	109	71
14	117	76
15	126	82
16	134	87
17	143	93
18	151	98
19	159	104
20	168	109
21	176	114
22	185	120
23	193	125
24	201	131
25	210	136
26	218	142
27	227	147
28	235	153
29	243	158
30	252	163
31	260	169
32	269	174
33	277	180
34	285	185
35	294	191
36	302	196
37	311	202
38	319	207
39	327	212
40	335	218
41	344	223
42	352	229
43	361	234
44	369	240
45	377	245
46	386	251
47	394	256
48	403	262
49	411	267
50	419	272
51	428	278
52	436	283
53	445	288
54	453	294
55	461	300
56	470	305
57	478	310
58	487	316
59	495	321
60	503	327
61	512	332
62	520	338
63	529	343
64	537	348
65	545	354
66	554	355
67	562	365
68	571	370

Min.	33. D.	57. D.
69	579	376
70	587	381
71	596	386
72	604	392
73	612	397
74	621	403
75	629	408
76	637	414
77	646	419
78	654	425
79	663	430
80	671	436
81	679	441
82	688	446
83	696	452
84	705	457
85	713	462
86	721	468
87	730	473
88	738	479
89	747	484
90	755	490
91	763	495
92	772	501
93	780	506
94	789	512
95	797	517
96	805	522
97	814	528
98	822	533
99	831	539
100	839	545
200	1677	1089
300	2516	1634

M.	34. d.	56. d.
1	8	6
2	17	11
3	25	17
4	33	22
5	41	28
6	50	34
7	58	39
8	66	45
9	75	50
10	83	56
11	91	61
12	99	67
13	108	73
14	116	78
15	124	84
16	133	89
17	141	95
18	149	101
19	158	106
20	166	112
21	174	117
22	182	123
23	191	129
24	199	134
25	207	140
26	216	145
27	224	151
28	232	157
29	240	162
30	249	168
31	257	173
32	265	179
33	274	184
34	282	190

M.	34. d.	56. d.
35	290	196
36	298	201
37	307	207
38	315	212
39	323	218
40	332	224
41	340	229
42	348	235
43	356	240
44	365	246
45	373	251
46	381	257
47	390	263
48	398	268
49	406	274
50	414	280
51	423	285
52	431	291
53	439	296
54	448	302
55	456	307
56	464	313
57	473	319
58	481	324
59	489	330
60	497	335
61	506	341
62	514	346
63	522	352
64	530	358
65	539	363
66	547	369
67	555	374
68	564	380

Min	34. D.	56. D.
69	572	386
70	580	391
71	588	397
72	597	403
73	605	408
74	613	414
75	622	419
76	630	425
77	638	431
78	647	436
79	655	442
80	663	447
81	671	453
82	680	458
83	688	464
84	696	470
85	705	475
86	713	481
87	721	486
88	729	492
89	738	498
90	746	503
91	754	509
92	763	514
93	771	520
94	779	526
95	788	531
96	796	537
97	804	542
98	812	548
99	821	554
100	829	559
200	1658	1118
300	2487	1678

M.	35. d.	55. d.	M.	35. d.	55. d.	Min.	35. D.	55. D.
1	8	6	35	286	201	69	565	396
2	17	11	36	295	206	70	573	402
3	25	17	37	303	212	71	582	407
4	33	23	38	311	218	72	590	413
5	41	29	39	319	224	73	598	419
6	49	34	40	328	229	74	606	425
7	57	40	41	336	235	75	615	430
8	66	46	42	344	241	76	623	436
9	74	52	43	352	246	77	631	442
10	82	57	44	360	252	78	639	448
11	90	63	45	368	258	79	647	453
12	98	69	46	377	264	80	655	459
13	106	75	47	385	270	81	664	465
14	115	80	48	393	275	82	672	470
15	123	86	49	401	281	83	680	476
16	131	92	50	410	287	84	688	482
17	139	98	51	418	292	85	696	488
18	147	103	52	426	298	86	705	493
19	156	109	53	434	304	87	713	499
20	164	115	54	442	310	88	721	505
21	172	120	55	451	315	89	729	511
22	180	126	56	459	321	90	737	516
23	188	132	57	467	327	91	746	522
24	196	138	58	475	333	92	754	528
25	205	143	59	483	338	93	762	534
26	213	149	60	491	344	94	770	539
27	221	155	61	500	350	95	778	545
28	229	161	62	508	356	96	786	551
29	237	166	63	516	361	97	795	556
30	246	172	64	524	367	98	803	562
31	254	178	65	533	373	99	811	568
32	262	184	66	541	379	100	819	574
33	270	189	67	549	384	200	1638	1147
34	278	195	68	557	390	300	2458	1721

M.	36. d.	54. d.	M.	36. d.	54. d.	Min.	36. D.	54. D.
1	8	6	35	283	206	69	558	406
2	16	12	36	291	211	70	566	411
3	24	18	37	299	217	71	574	417
4	32	23	38	307	223	72	582	423
5	40	29	39	315	229	73	590	429
6	48	35	40	324	235	74	599	435
7	57	41	41	332	241	75	607	441
8	65	47	42	340	247	76	615	447
9	72	53	43	348	253	77	623	453
10	81	59	44	356	258	78	631	458
11	89	65	45	364	264	79	639	464
12	97	70	46	372	270	80	647	470
13	105	76	47	380	276	81	655	476
14	113	82	48	388	282	82	663	482
15	121	88	49	396	288	83	671	488
16	129	94	50	404	294	84	680	494
17	138	100	51	413	300	85	688	500
18	146	106	52	421	306	86	696	506
19	154	112	53	429	311	87	704	511
20	162	118	54	437	317	88	712	517
21	170	123	55	445	323	89	720	523
22	178	129	56	453	329	90	728	529
23	186	135	57	461	335	91	736	535
24	194	141	58	469	341	92	744	541
25	202	147	59	477	347	93	752	547
26	210	153	60	485	353	94	760	553
27	218	159	61	493	358	95	768	558
28	226	164	62	502	364	96	777	564
29	235	170	63	510	370	97	785	570
30	243	176	64	518	376	98	793	576
31	251	182	65	526	382	99	801	582
32	259	188	66	534	388	100	809	588
33	267	194	67	542	394	200	1618	1176
34	275	200	68	550	400	300	2427	1763

M.	37. d.	53. d.
1	8	6
2	16	12
3	24	18
4	32	24
5	40	30
6	48	36
7	56	42
8	64	48
9	72	54
10	80	60
11	88	66
12	96	72
13	104	78
14	112	84
15	120	90
16	128	96
17	136	102
18	144	108
19	152	114
20	160	120
21	168	126
22	176	132
23	184	138
24	192	144
25	200	150
26	208	156
27	216	162
28	224	168
29	232	174
30	240	180
31	248	186
32	256	192
33	264	198
34	271	204

M.	37. d.	53. d.
35	279	210
36	287	216
37	295	222
38	303	228
39	311	234
40	319	241
41	327	247
42	335	253
43	343	259
44	351	265
45	359	271
46	367	277
47	375	283
48	383	289
49	391	295
50	399	301
51	407	307
52	415	313
53	423	319
54	431	325
55	439	331
56	447	337
57	455	343
58	463	349
59	471	355
60	479	361
61	487	367
62	495	373
63	503	379
64	511	385
65	519	391
66	527	397
67	535	403
68	543	409

M.	37. D.	53. D.
69	551	415
70	559	421
71	567	427
72	575	433
73	583	439
74	591	445
75	599	451
76	607	457
77	615	463
78	623	469
79	631	475
80	639	481
81	647	487
82	655	493
83	663	500
84	671	506
85	679	512
86	687	518
87	695	524
88	703	530
89	711	536
90	719	542
91	727	548
92	735	554
93	743	560
94	751	566
95	759	572
96	767	578
97	775	584
98	783	590
99	791	596
100	799	602
200	1597	1204
300	2396	1805

M.	38. d.	52. d.	M.	38. d.	52. d.	Min.	38. D.	52. D.
1	8	6	35	276	216	69	544	425
2	16	12	36	284	222	70	552	431
3	24	18	37	292	228	71	559	437
4	31	25	38	299	234	72	567	443
5	39	31	39	307	240	73	575	450
6	47	37	40	315	246	74	583	456
7	55	43	41	323	252	75	591	462
8	63	49	42	331	259	76	599	468
9	71	55	43	339	265	77	607	474
10	79	62	44	347	271	78	615	480
11	87	68	45	355	277	79	622	486
12	95	74	46	362	283	80	630	493
13	102	80	47	370	289	81	638	499
14	110	86	48	378	296	82	646	505
15	118	92	49	386	302	83	654	511
16	126	99	50	394	308	84	662	517
17	134	105	51	402	314	85	670	523
18	142	111	52	410	320	86	678	529
19	150	117	53	418	326	87	686	536
20	158	123	54	426	332	88	693	542
21	166	129	55	433	339	89	701	548
22	173	136	56	441	345	90	709	554
23	181	142	57	449	351	91	717	560
24	189	148	58	457	357	92	725	566
25	197	154	59	465	363	93	733	573
26	205	160	60	473	369	94	741	579
27	213	166	61	481	376	95	749	585
28	221	172	62	489	382	96	756	591
29	229	179	63	496	388	97	764	597
30	236	185	64	504	394	98	772	603
31	244	191	65	512	400	99	780	610
32	252	197	66	520	406	100	788	616
33	260	203	67	528	412	200	1576	1231
34	268	209	68	536	419	300	2364	1847

M.	39. d.	51. d.	M.	39. d.	51. d.	Min.	39. D.	51. D.
1	8	6	35	272	220	69	536	434
2	16	13	36	280	226	70	544	440
3	23	19	37	287	233	71	552	447
4	31	25	38	295	239	72	559	453
5	39	31	39	303	245	73	567	459
6	47	38	40	311	252	74	575	466
7	54	44	41	318	258	75	583	472
8	62	50	42	326	264	76	591	478
9	70	57	43	334	271	77	598	485
10	78	63	44	342	277	78	606	491
11	85	69	45	350	283	79	614	497
12	93	75	46	357	289	80	622	503
13	101	82	47	365	296	81	629	510
14	109	88	48	373	302	82	637	516
15	116	94	49	381	308	83	645	522
16	124	101	50	388	315	84	653	529
17	132	107	51	396	321	85	661	535
18	140	113	52	404	327	86	668	541
19	148	119	53	412	334	87	676	547
20	155	126	54	419	340	88	684	554
21	163	132	55	427	346	89	692	560
22	171	138	56	435	352	90	699	566
23	179	145	57	443	359	91	707	573
24	186	151	58	451	365	92	715	579
25	194	157	59	458	371	93	723	585
26	202	164	60	466	378	94	731	591
27	210	170	61	474	384	95	738	598
28	217	176	62	482	390	96	746	604
29	225	182	63	489	396	97	754	610
30	233	189	64	497	403	98	762	617
31	241	195	65	505	409	99	769	623
32	249	201	66	513	415	100	777	629
33	256	208	67	521	422	200	1554	1259
34	264	214	68	528	428	300	2331	1888

M.	40. d.	50. d.	M.	40. d.	50. d.	Min.	40. D.	50. D.
1	8	6	35	268	225	69	529	443
2	15	13	36	276	231	70	536	450
3	23	19	37	283	238	71	544	456
4	31	26	38	291	244	72	552	463
5	38	32	39	299	251	73	559	469
6	46	38	40	306	257	74	567	476
7	54	45	41	314	263	75	574	482
8	61	51	42	322	270	76	582	485
9	69	58	43	329	276	77	590	495
10	77	64	44	337	283	78	597	501
11	84	71	45	345	289	79	605	508
12	92	77	46	352	296	80	613	514
13	100	83	47	360	302	81	620	521
14	107	90	48	368	309	82	628	527
15	115	96	49	375	315	83	636	533
16	123	103	50	383	321	84	643	540
17	130	109	51	391	328	85	651	546
18	138	116	52	398	334	86	659	553
19	146	122	53	406	341	87	666	559
20	153	129	54	414	347	88	674	566
21	161	135	55	421	353	89	682	572
22	169	141	56	429	360	90	689	579
23	176	148	57	437	366	91	697	585
24	184	154	58	444	373	92	705	591
25	192	161	59	452	379	93	712	598
26	199	167	60	460	386	94	720	604
27	207	173	61	467	392	95	727	611
28	214	180	62	475	399	96	735	617
29	222	186	63	483	405	97	743	623
30	230	193	64	490	411	98	751	630
31	237	199	65	498	418	99	758	636
32	245	206	66	506	424	100	766	643
33	253	212	67	513	431	200	1532	1286
34	260	219	68	521	437	300	2298	1928

M.	41. d	49. d	M.	41. d	49. d	Min	41. D.	49. D.
1	8	7	35	264	229	69	521	452
2	15	13	36	272	236	70	528	459
3	23	20	37	279	243	71	536	466
4	30	26	38	287	249	72	543	472
5	38	33	39	294	256	73	551	478
6	45	39	40	302	262	74	558	485
7	53	46	41	309	269	75	566	492
8	60	52	42	317	275	76	574	498
9	68	59	43	324	282	77	581	505
10	75	66	44	332	289	78	589	512
11	83	72	45	339	295	79	596	518
12	91	79	46	347	302	80	604	525
13	98	85	47	354	308	81	611	531
14	106	92	48	362	315	82	619	538
15	113	98	49	369	321	83	626	544
16	121	105	50	377	328	84	634	551
17	128	112	51	385	334	85	641	557
18	136	118	52	392	341	86	649	564
19	143	125	53	400	348	87	656	571
20	151	131	54	407	354	88	664	577
21	159	138	55	415	361	89	671	584
22	166	144	56	422	367	90	679	590
23	174	151	57	430	374	91	687	597
24	181	157	58	438	380	92	694	603
25	189	164	59	445	387	93	702	610
26	196	171	60	453	394	94	709	616
27	204	177	61	460	400	95	717	623
28	211	184	62	468	407	96	724	629
29	219	190	63	475	413	97	732	636
30	226	197	64	483	420	98	739	643
31	234	203	65	490	426	99	747	649
32	241	210	66	498	433	100	755	656
33	249	216	67	506	439	200	1509	1312
34	257	223	68	513	446	300	2264	1968

M.	42. d.	48. d.
1	7	7
2	15	13
3	22	20
4	30	27
5	37	33
6	44	40
7	52	47
8	59	53
9	67	60
10	74	67
11	82	73
12	89	80
13	97	87
14	104	93
15	111	100
16	119	107
17	126	113
18	134	120
19	141	127
20	149	134
21	156	140
22	163	147
23	171	154
24	178	160
25	186	167
26	193	174
27	201	180
28	208	187
29	215	194
30	223	201
31	230	207
32	238	214
33	245	221
34	253	227
35	260	234
36	267	241
37	275	247
38	282	254
39	290	261
40	297	268
41	304	274
42	312	281
43	319	287
44	327	294
45	334	301
46	342	308
47	349	314
48	357	321
49	364	328
50	372	335
51	379	341
52	386	348
53	394	354
54	401	361
55	409	368
56	416	375
57	423	381
58	431	388
59	438	394
60	446	401
61	453	408
62	461	415
63	468	421
64	475	428
65	483	435
66	490	442
67	498	448
68	505	455

Min.	42. D.	48. D.
69	513	462
70	520	468
71	527	475
72	535	482
73	542	488
74	550	495
75	557	502
76	564	509
77	572	515
78	579	522
79	587	529
80	594	535
81	602	542
82	609	549
83	617	555
84	624	562
85	632	569
86	639	575
87	647	582
88	654	589
89	661	595
90	669	602
91	676	609
92	684	615
93	691	622
94	699	629
95	706	635
96	713	642
97	721	649
98	728	655
99	736	662
100	743	669
200	1486	1338
300	2229	2007

M.	43. d.	47. d.	M.	43. d.	47. d.	M.	43. D.	47. D.
1	7	7	35	256	239	69	505	470
2	15	14	36	263	245	70	512	477
3	22	20	37	270	252	71	519	484
4	29	27	38	278	259	72	526	491
5	36	34	39	285	266	73	534	498
6	44	41	40	292	273	74	541	505
7	51	48	41	300	280	75	548	511
8	58	54	42	307	286	76	556	518
9	66	61	43	314	293	77	563	525
10	73	68	44	322	300	78	570	532
11	80	75	45	329	307	79	578	539
12	88	82	46	336	314	80	585	546
13	95	89	47	344	320	81	592	552
14	102	95	48	351	327	82	600	559
15	110	102	49	358	334	83	607	566
16	117	109	50	366	341	84	614	573
17	124	116	51	373	348	85	622	580
18	132	123	52	380	355	86	629	587
19	139	130	53	388	361	87	636	593
20	146	136	54	395	368	88	643	600
21	153	143	55	402	375	89	651	607
22	161	150	56	409	382	90	658	614
23	168	157	57	417	389	91	665	621
24	175	164	58	424	395	92	673	627
25	183	170	59	431	402	93	680	634
26	190	177	60	439	409	94	687	641
27	197	184	61	446	416	95	695	648
28	205	191	62	453	423	96	702	655
29	212	198	63	461	430	97	709	661
30	219	205	64	468	436	98	717	668
31	227	211	65	475	443	99	724	675
32	234	218	66	483	450	100	731	682
33	241	225	67	490	457	200	1463	1364
34	248	232	68	497	464	300	2194	2046

M.	44. d.	46. d.	M.	44. d.	46. d.	Min.	44. D.	46. D.
1	7	7	35	252	243	69	496	479
2	14	14	36	259	250	70	503	486
3	22	21	37	266	257	71	511	493
4	29	28	38	273	264	72	518	500
5	36	35	39	280	271	73	525	507
6	43	42	40	288	278	74	532	514
7	50	49	41	295	285	75	539	521
8	58	56	42	302	292	76	547	528
9	65	62	43	309	299	77	554	535
10	72	69	44	316	306	78	561	542
11	79	76	45	324	313	79	568	549
12	86	83	46	331	320	80	575	556
13	93	90	47	338	327	81	583	563
14	101	97	48	345	334	82	590	570
15	108	104	49	352	340	83	597	577
16	115	111	50	360	347	84	604	584
17	122	118	51	367	354	85	611	590
18	129	125	52	374	361	86	619	597
19	137	132	53	381	368	87	626	604
20	144	139	54	388	375	88	633	611
21	151	146	55	396	382	89	640	618
22	158	153	56	403	389	90	647	625
23	165	160	57	410	396	91	655	632
24	173	167	58	417	403	92	662	639
25	180	174	59	424	410	93	669	646
26	187	181	60	432	417	94	676	653
27	194	188	61	439	424	95	683	660
28	201	195	62	446	431	96	690	667
29	209	201	63	453	438	97	698	674
30	216	208	64	460	445	98	705	681
31	223	215	65	468	452	99	712	688
32	230	222	66	475	458	100	719	695
33	237	229	67	482	465	200	1439	1389
34	245	236	68	489	472	300	2158	2084

M.	45. d.	45. d.
1	7	7
2	14	14
3	21	21
4	28	28
5	35	35
6	42	42
7	49	49
8	56	56
9	64	64
10	71	71
11	78	78
12	85	85
13	92	92
14	99	99
15	106	106
16	113	113
17	120	120
18	127	127
19	134	134
20	141	141
21	148	148
22	155	155
23	163	163
24	170	170
25	177	177
26	184	184
27	191	191
28	198	198
29	205	205
30	212	212
31	219	219
32	226	226
33	233	233
34	240	240

M.	45. d.	54. d.
35	247	247
36	254	254
37	261	261
38	268	268
39	275	275
40	283	283
41	290	290
42	297	297
43	304	304
44	311	311
45	318	318
46	325	325
47	332	332
48	339	339
49	346	346
50	353	353
51	360	360
52	367	367
53	375	375
54	382	382
55	389	389
56	396	396
57	403	403
58	410	410
59	417	417
60	424	424
61	431	431
62	438	438
63	445	445
64	452	452
65	459	459
66	466	466
67	474	474
68	481	481

Min.	45. D.	45. D.
69	488	488
70	495	495
71	502	502
72	509	509
73	516	516
74	523	523
75	530	530
76	537	537
77	544	544
78	551	551
79	558	558
80	566	566
81	573	573
82	580	580
83	587	587
84	594	594
85	601	601
86	608	608
87	615	615
88	622	622
89	629	629
90	636	636
91	643	643
92	650	650
93	657	657
94	665	665
95	672	672
96	678	678
97	686	686
98	693	693
99	700	700
100	707	707
200	1414	1414
300	2121	2121

Now for the forme of ſetting downe a Reckoning although he which is accuſtomed to keepe it in this manner, may haply by uſe and practice diſcerne how to order it in a better way than I can preſently preſcribe or thinke upon, becauſe he hath occaſion often to conſider it in every particular: yet in the meane time I conceive it will be fit to have a Booke in *folio*, that is, two Leaves to a ſheet of paper, and to keep the left ſide of you booke void, that you may write therein all ſuch Occurrents as you ſhall thinke requiſite. As namely, the Winds and the Points of the *Compaſſe* upon which your Ship lyes, and what allowance you make for *Leeward*-way when you ſayle by a Wind, the number of Glaſſes or Houres, and how many Knots or Miles in each houre, alſo the *Latitudes* which you find by obſervation of the Meridian-altitude of the Starres, and what elſe you ſhall thinke remarkable. But before all this, the title of the Voyage in theſe or like words.

The Iournall of our Voyage intended by Gods aſsiſtance from S. J. *in the Latitude of* 32 *deg.* 25. *min. to the coaſt of* England, *&c.*

The right hand Pages, or the right ſide of your booke throughout may by lines be divided into 12 Columes, as in the Example following doth appeare. In the firſt Colume may be expreſſed the *day*, in the ſecond, *moneth*, (or at leaſt once in the top of the page) likewiſe in the ſame 2 Colume, being large enough, may be ſet downe the *Latitudes* which you find by the *Meridan-altitudes* of the Sunne at ſuch times as you make obſervation. In the third Col. the courſe (the *Leeward*-way, if there be any leeing allowed.) In the 4, the *variation of the Needle*. In the 5, (having made allowance for the *Variation*) ſet downe the Angle of your *Rumbe* with the *Meridian*. In the 6 Col. ſet downe the *diſtance* in miles run upon that *Rumbe*. In the 7, 8, 9, and 10 Columes, the *Northing* or *Southing*, *Eaſting* or *Weſting*, thereto anſwering, as you ſhall find it by your *Table*. In the 11, your *Latitudes* by dead reckoning. And laſtly, in the 12 Colume, you may at ſuch times as you thinke fitteſt, ſet downe your *Longitude* from the place from which you firſt departed, or the difference of Longitude from place to place.

Da	and Lat. by observation	course.	Variation.	Degr. from the Merid.	Dista. in mil.	North	Sou.	East	West	Lat. by dead R.	Longitude.
										d. m.	
20	February	N E. by E.	8 deg West.	NE. 48 d.	miles 78	522		579		33.17	
21	Latitude 34 d. 25'.	N E. by E.	8 deg west.	Ne. 48 d.	100	669		743		34.24	
21	34 d. 25'.				Summe is	1191		1322		34.24	02.38
22		E ne	8 deg ½ point west.	Ne. 54 d.	100	588		809		35.56	
					56	329		453			
23	Latitude 37 d. 46.	E ne	8 deg ½ no. west.	Ne. 54 d.	100	588		809		37.40	
					78	458		631			
24	Latitude 39. d. 36.	E ne	8 deg ½ no. west.	Ne. 54 d.	100	588		809		39 28	
					84	494		679			
					Summe is	3045		4190			
		The correction by observation is				80		110		08	
24	39 d. 36.					3125		4300		39.36	11.36
25	February	E ne	8 deg west.	Ne. 59 ½	100	507		861		41.05	
					76	385		655			
26		E ne	8 deg west.	Ne. 59 ½	100	507		861		42.37	
					80	412		686			
27	Latitude 43 d. 55'.	E ne	7½ de west.	Ne. 60 d.	100	500		866		44.09	
					84	420		728			
					Summe is	2731		4657			
					Correction		140		245	14	
27	Lat. 43.55					2591		4412		43.55	21.38
28	February	E ne	6 deg ½ east west.	Ne 67 d.	100	391		921		44.54	
					51	199		469			
29		E ne	5 deg ½ east west.	Ne 68 d.	100	375		927		46.02	
					81	304		751			
1	March	E ne	4 deg ½ east west.	Ne 69 d.	100	358		934		47.02	
					66	237		616			
2	La. 48.04	E ne	2 deg ½ east west.	Ne 71 d.	100	326		946		48.00	
					78	254		737			
2	La. 48.04				Summe is	2444		6301		48.00	36.38

Da	Lat. By observation.	course.	Variation.	Deg. from the Merid.	dist. in Miles.	North	Sou.	East.	West	Lat. by dead R.	Longitude.
3	March	E n e ½ east	0 deg Welt	Ne. 73 d	100	292		956		48.44	
					52	152		497			
4		E n e ½ east	2 deg East	Ne. 71 d	100	259		966		49.28	
					68	176		657			
5	Latitude 49 d. 58.	E n e ½ east	3 deg East	Ne. 76 d	98	237		951		49.52	
5	La. 49. 58			Summe is		1116		4027		49.52	46 52
5	8 Houres	N by E ½ E	4 deg East	NE. 21 d	18	168		64		50.09	
6		South by E.	4 deg East	S E. 07 d	34		337	41		49.35	
6	16 Hour.	N by East.	4 deg East	NE. 15 d	36	348		93		50.10	
7		S East by E	4 deg East	SE. 52 d	20		123	158		49.58	
8	Latitude 50 d. 04 m	East	4 deg East	SE. 86 d	96		67	958		49 51	
	The curret setting by estima.	ENE		NE. 67½	60	230		554		50.14	
				Summe is		219		1868			
				Correct.			100			10	
8	Lat. 50.04					119		1868		50 04	51.43
9		East ½ po. N	6 deg East	Se. 89½ d	70		60	700		49.58	
10		East ½ po. N	6 deg East	Se. 89½ d	52		41	520		49.54	
10	March			Summe is			101	1220		49.54	54.53
	Here the *Lizard* beares	N by East			13						

For an example, we may frame a reckoning betweene the two places before mentioned, namely from *Summers-Ilands* to the *Lizard*, whose distance in their rumbe we have before supposed to be 3299 miles as some Charts make it, and consequently their difference of Longitude 70 deg. J would not be understood as if J affirmed it to be so much, for I suppose it is lesse J was there indeed about 20 yeares past and survayed it, and then kept a reckoning both outwards and homewards, but J have lost those reckoning, long since, and have forgotten what they were, and in this case it matters not, for whether the supposition be neare the truth or not, it serves sufficiently to exemplifie the rule, that being the end for which it is used. But if their distance be 3299, such miles as containe onely 1000 pases in a mile, the same being reckoned in such miles as we have before-mentioned, namely in such whereof 60 make a degree of a great Circle, which as we finde containe 6120 feet in a mile: there distance will be little more then 3695 miles; and consequently, the difference of Longitude little more then 55 $\frac{1}{6}$ degrees.

Let us therefore suppose the difference of Longitude between those two places to be 55 degrees, and their Latitudes to be the same as before, namely of the one 32 deg, 25 min. and of the other 50 degrees. And let the Courses, Distances and other observations from *Summers-Ilands* to the *Lizard* be such as before is shewed.

This first entrance in this Journall (which is the 20 day of *February*) is thus to be understood; namely that from the time of setting saile (which we suppose to be the 19 of *February*) till the 20 day at noone, the ship lies away and makes her way good upon the Northeast and by E. point of the Compasse; but the variation being 8 deg. to the Westwards (as in the fourth colume appeares) the rumbe upon which she hath runne is from the North to the Eastwards onely 48 deg. as is expressed in the 5 colume (it is indeed 48 $\frac{1}{2}$ deg. but the $\frac{1}{2}$ deg. we omit as for the other circumstances not to be regarded) upon this rumbe she runnes 78 miles, as in the 6 colume appeares and answerable thereto I find in the Table before-going, the Northing to be 52 $\frac{3}{10}$ miles, and the Easting 57 $\frac{8}{10}$ miles, as here in the 7 and 9 columes is expreſt

by

by these numbers 522 and 579 (for the first figure towards the right hand signifieth the tenth parts of a mile, the rest Miles.) Hence then the Northing being 52 miles, if that be added to the Latitude from which it is reckoned, namely 32 deg. 25 min. it makes the Latitude here to be 33 deg. 17 m. as in the 11 colume appeares. In like sort the second entrance being the 21 of *February*, sheweth that from the 20 day at noone to the 21 she made her way good upon Northeast and by East point of the Compasse, but the Variation being 8 deg. Westerly, the angle of the rumbe with the true Meridian was from the North to the Eastwards 48 deg. and so sayling 100 miles, the Northing is 69 $\frac{1}{10}$ miles, and the Easting 74 $\frac{1}{10}$ miles; so that the Latitude now is 34 deg. 24 min. and the like is to be understood of all the rest.

Touching the Longitude expressed in the last colume, although a reckoning may be kept and set downe without it, yet it is of very good use, and how to convert the Easting or Westing (that is the miles expressed in the East and West columes of your journall) into deg. and min. of Longitude, we will shew afterwards, as also how you may easily correct your course, and give the true course or rumbe allowing the Variation.

But first to proceed with this Journall, observing the Meridian altitude of the Sunne upon the 23 and 24 of *February* I find that my Latitude upon the 24 day is 39 deg. 36 min. whereas by dead reckoning it is but 39 deg. 28 min. so the difference is 8 more Northerly; but being well assured of the Latitude found by Observation, I correct the dead reckoning thereby, which may be done by the Rule of Proportion saying;

As the summe of the North colume	3125.	*Co: ar:*	6, 50515
To the summe of the East colume,	4300	——	3, 63347
So the foresaid increase Northerly	80	——	1, 90309
To the increase Easterly,	110	——	2, 04171

that is 11 Miles: for the first place towards the right hand is onely for the the tenth parts of a mile.

The same may also sufficiently be found without the Rule of Proportion by the fore-going *Table*, onely for looking there under the Degree upon which I have sayled; namely, under 54

deg. for 8 miles or 80 tenths of a mile, though I find not the ſame exactly, yet I find one which is neere it, namely 82, and againſt it in the next collaterall colume 113, which is 11 1/10 miles, (being too much by 1/10 of a mile, becauſe the other is too much by 1/10) I adde therefore in the North colume of the journall 8 miles and in the Eaſt colume 11 miles: And ſo whereas by dead reckoning, the northing was but 304, 5/10 and the eaſting 419 miles: now having corrected it by obſervation, the Northing is 312 1/10 miles, and Eaſting 430 miles.

In like ſort upon the 27 day, I ſhould by dead reckoning be in the Latitude of 44 deg. 09 min. but by a cleare and good obſervation, I find my ſelfe in the Latitude of 43 deg. 55 min. that is not ſo much northerly by 14 min. therefore to correct it I put in the South colume 14 miles or 140 tenths, and ſeeing my courſe was betweene the North and the Eaſt, and that I find my ſelfe to bee leſſe to the Northwards, that is, more to the ſouthwards then my reckoning, therefore in probability I am alſo leſſe to the Eaſtwards, that is more to the weſtwards then my reckoning; but to find how much, I looke in the foregoing Table for the degree upon which I have ſayled, being from the North part of the Meridian to the Eaſtwards 60 deg. and under 60 deg. I looke for 14 miles or 140 tenths, and againſt it in the colume adjoyning I find 243 which I ſet downe in my journall in the weſt colume, and ſo ſubtracting the firſt from the North colume, the other from the Eaſt: I find that whereas by dead reckoning I ſhould be to the northwards 273, 5/10 miles and to the Eaſtwards, 465, 7/10. Now having corrected it by obſervation, I find that from the 24 day till this time, I have runne more northerly then I was by 259 3/10 miles, and more Eaſterly by 441, 7/10 miles.

But if your courſe be neere the Eaſt or Weſt, it may ſuffice to correct it in Latitude onely, as in the example of the 8 of *March* appeares; for in that caſe you cannot correct the Longitude but from ſome further ground.

If there be any current you may note it as is done in that Example following the 8 of *March*.

Now if you would ſet downe this reckoning upon the Plaine or Common *Sea-chart*: Firſt, if you deſire to expreſſe every

daves

dayes account, you may begin for the 20 of *February*, and make a prick in your platt that may be from the place from which you ſet ſayle to the Northwards 52 $\frac{1}{2}$ miles, and to the Eaſtwards 57 $\frac{1}{2}$; and ſo will this point be diſtant from the place of your ſetting ſayle 78 miles Northeaſt, and almoſt a quarter of a point Eaſterly: then for the 21 day you make another Prick which may be from the forme to the Northwards 66 $\frac{1}{2}$ miles, and to the Eaſtwards 74 $\frac{1}{2}$ miles, and ſo you may proceed with the reſt. And thus you ſhall have a Prick on the Plot for every day more exactly ſet downe then could be done after the ordinary way by Courſe and Diſtance, or Courſe and Latitude, eſpecially becauſe in ſyning the Plot, there are not, nor cannot conveniently be drawne any more then the 32 Points of the *Compaſſe*; to wit, not halfe Points, quarters, or ſingle Degrees.

But if you deſire not to ſet downe every dayes reckoning (which is not neceſſary to be done) you may ſet downe every of the Summes as they are corrected by obſervation after the ſelfſame manner.

Or you may adde together all thoſe ſummes, and ſo the ſumme totall of the North colume will be 1049 miles, and of the Eaſt Colume 2345 miles; therefore in the *Meridian* of the place from which you depart, you may ſet downe to the Northwards of that place 1049 miles, which will fall in the Latitude of 49 Degrees 54 min. almoſt, and from thence in that Parallel ſet downe directly to the Eaſtwards 2345 miles, and there make a prick for the place where the Ship then is the tenth of *March*, and ſo is all this reckoning ſet downe at once.

If you keepe reckoning according to *Mercator*, it will be requiſit ſometimes to ſum up your reckonings paſt, namely ſo often as you make any notable alteration in your Courſe: And ſo this reckoning or any other may be ſet downe almoſt as eaſily on *Mercators-chart*, the difference is, that here you muſt often alter your *Scale*, becauſe the deg. of Latitude on this *Chart* are not equall but grow greater and greater towards the Poles. Now then the diſtance of two places is to be meaſured by that part of the *Meridian* which is intercepted betweene the Latitudes of thoſe

two

deg. for 8 miles or 80 tenths of a mile, though I find not the ſame exactly, yet I find one which is neere it, namely 82, and againſt it in the next collaterall columne 113, which is 11 $\frac{3}{10}$ miles, (being too much by $\frac{3}{10}$) I adde therefore in the North columne of the journall 8 miles and in the Eaſt columne 11 miles: And ſo whereas by dead reckoning, the northing was but 304 $\frac{1}{10}$ and the eaſting 419 miles: now having corrected it by obſervation, the Northing is 312 $\frac{1}{10}$ miles, and Eaſting 430 miles.

In like ſort upon the 27 day, I ſhould by dead reckoning be in the Latitude of 44 deg. 09 min. but by a cleare and good obſervation, I find my ſelfe in the Latitude of 43 deg. 55 min. that is not ſo much northerly by 14 min. therefore to correct it I put in the South columne 14 miles or 140 tenths, and ſeeing my courſe was betweene the North and the Eaſt, and that I find my ſelfe to bee leſſe to the Northwards, that is, more to the ſouthwards then my reckoning, therefore in probability I am alſo leſſe to the Eaſtwards, that is more to the weſtwards then my reckoning; but to find how much, I looke in the foregoing Table for the degree upon which I have ſayled, being from the North part of the Meridian to the Eaſtwards 60 deg. and under 60 deg. I looke for 14 miles or 140 tenths, and againſt it in the columne adjoyning I find 243 which I ſet downe in my journall in the weſt columne, and ſo ſubtracting the firſt from the North columne, the other from the Eaſt: I find that whereas by dead reckoning I ſhould be to the northwards 273 $\frac{1}{10}$ miles and to the Eaſtwards, 465 $\frac{7}{10}$. Now having corrected it by obſervation, I find that from the 24 day till this time, I have runne more northerly then I was by 259 $\frac{1}{10}$ miles, and more Eaſterly by 441 $\frac{3}{10}$ miles.

But if your courſe be neere the Eaſt or Weſt, it may ſuffice to correct it in Latitude onely, as in the example of the 8 of *March* appeares; for in that caſe you cannot correct the Longitude but from ſome further ground.

If there be any current you may note it as is done in that Example following the 8 of *March*.

Now if you would ſet downe this reckoning upon the Plaine or Common *Sea-chart*: Firſt, if you deſire to expreſſe every

daves

dayes account, you may begin for the 20 of *February*, and make a prick in your platt that may be from the place from which you ſet ſayle to the Northwards 52 $\frac{1}{2}$ miles, and to the Eaſtwards 57 $\frac{1}{2}$; and ſo will this point be diſtant from the place of your ſetting ſayle 78 miles Northeaſt, and almoſt a quarter of a point Eaſterly: then for the 21 day you make another Prick which may be from the forme to the Northwards 66 $\frac{1}{2}$ miles, and to the Eaſtwards 74 $\frac{1}{2}$ miles, and ſo you may proceed with the reſt. And thus you ſhall have a Prick on the Plot for every day more exactly ſet downe then could be done after the ordinary way by Courſe and Diſtance, or Courſe and Latitude, eſpecially becauſe in ſyning the Plot, there are not, nor cannot conveniently be drawne any more then the 32 Points of the *Compaſſe*; to wit, not halfe Points, quarters, or ſingle Degrees.

But if you deſire not to ſet downe every dayes reckoning (which is not neceſſary to be done) you may ſet downe every of the Summes as they are corrected by obſervation after the ſelfſame manner.

Or you may adde together all thoſe ſummes, and ſo the ſumme totall of the North colume will be 1049 miles, and of the Eaſt Colume 2345 miles; therefore in the *Meridian* of the place from which you depart, you may ſet downe to the Northwards of that place 1049 miles, which will fall in the Latitude of 49 Degrees 54 min. almoſt, and from thence in that Parallel ſet downe directly to the Eaſtwards 2345 miles, and there make a prick for the place where the Ship then is the tenth of *March*, and ſo is all this reckoning ſet downe at once.

If you keepe reckoning according to *Mercator*, it will be requiſit ſometimes to ſum up your reckonings paſt, namely ſo often as you make any notable alteration in your Courſe: And ſo this reckoning or any other may be ſet downe almoſt as eaſily on *Mercators-chart*, the difference is, that here you muſt often alter your *Scale*, becauſe the deg. of Latitude on this *Chart* are not equall but grow greater and greater towards the Poles. Now then the diſtance of two places is to be meaſured by that part of the *Meridian* which is intercepted betweene the Latitudes of thoſe

two

two places; Or if both places lye in one and the ſame Latitude, their Diſtance is meaſured by a Degree or other leſſer quantity, taken about that Latitude; namely, halfe above, and half beneath.

Wherefore if you would make a Prick or Traverſe-point in *Mercators-Chart*, anſwering to your Reckoning for the firſt day, namely untill the 20 of *February* at Noone, it appeares by your Journall that Prick muſt be to the Northwards of the place from which you departed 52, $\frac{2}{3}$ Miles, and to the Eaſtwards 57, $\frac{2}{3}$ miles.

Now in ſtead of the *North* or *South* columes, you may more conveniently uſe the laſt Colume but one, ſhewing in what Latitude every account doth fall; and ſo it appeares, that the Prick for the 20 of *February* muſt be in the *Latitude* of 33 deg. 17 min. Therfore in the Meridian of the *Summer-Ilands* from which you departed, make a prick in the Latitude of 33 deg. 17 min. and from that Prick ſet down to the *Eaſtwards* in the ſame Latitude 57, $\frac{2}{3}$ miles, and where it ends is the Traverſe-point anſwering to the 20 of *February*: the like may be done for the 21 day, and ſo for all the reſt. This 58 Miles may be taken in the Meridian from the Latitude of 32 deg. 22 min. to the Latitude of 33 deg. 20 min. or otherwiſe you may take the halfe of it which is 29 Miles about the middle betweene both Latitudes and double it.

But it is ſufficient to ſet downe the ſummes of every two or three dayes accounts, or ſo often as there is any notable Difference in your Courſe; Thus if you would make a Prick in the *Chart*, anſwering to the 21 of *February* being the firſt Summe; I ſee by the Journall that it muſt be in the Latitude of 34 deg. 24 min. and to the *Eaſtwards* of the place from which I departed 132, $\frac{2}{3}$ Miles. Therefore in the Meridian of the place from which I departed, I make a Prick in the Latitude of 34 deg. 24 min. and from that Prick I ſet in the ſame Latitude to the *Eaſtwads* 132, $\frac{2}{3}$ Miles, and where it ends is the Traverſe-point anſwering to the 21 of *February* being the firſt ſumme. This 132 miles may be taken in the Meridian within, or a little without the two Latitudes as before, namely from 32 deg. 20 min. to 34 deg. 32 minutes.

In like ſort, if you would make a Prick for the ſecond Summe being the 24 of *February*, it there appeares that it muſt be in the Latitude of 39 deg. 36 minutes, and to the *Eaſtwards* of the Traverſe-

verſe-point laſt before made 430 Miles; therefore in the Meridian of that Traverſe-point I make a Prick in the Latitude of 39 deg. 36 min. and from that Prick I ſet to the Eaſtwards in the ſame Latitude 430 miles, and where that ends, is the Traverſe-point anſwering to the 24 day, and the like is to be underſtood of all the reſt.

Now this 430 Miles may be taken ſeverall wayes; for firſt if I take one Degree about the middle of that part of the Meridian which is intercepted betweene the Latitudes of the two places (as from 36 deg. 30 min. to 37 deg. 30 minutes) and that degree ſeven times taken is 420 Miles, then about the middle, namely 37 deg. I take 10 minutes more, and ſo I have 430 Miles.

In like manner, you may take two deg. or 120 miles, to meaſure it thereby, which may be taken from 36 deg. to 38 degrees, and the reſidue about 37 degrees, as before, &c.

Or you may take the halfe of 430 Miles, namely 215 Miles, which is 3 deg. 35 min. which muſt be taken as before, about the middle of that part of the Meridian which is intercepted betweene the two Latitudes, and that doubled is 430 Miles, to be ſet to the Eaſtwards as before.

And thus may this or any other Reckoning be ſet downe without knowledge of the Longitudes, but more aptly and exactly by ſome Longitudes knowne, for then ſhall you have in the two laſt Columes the ſubſtance and principall ſcope of your reckoning; namely, the Latitudes and Longitudes of all Places as you Sayle, which may more eaſily and exactly be expreſt upon this *Chart*, then the Eaſterly or Weſterly diſtances; Therefore how this alſo may be done we will ſhew, but firſt ſomething touching the *Compaſſe* and the *Variation* thereof, which ought not to be neglected in a Reckoning.

CHAP. X.

Of the Variation of the Compasse, and how to rectifie a Course by the Variation knowne.

AMongst all the Mysteries which God hath of late yeares discovered to the World for the furtherance of *Navigation*, there is none more necessary nor yet more admirable then that property of the *Needle* touched with the Loadstone, whereby in the vast Ocean where all Land-markes faile, yea even in the darkest Nights and closest weather, when neither Sunne nor Starres are to be seene: The Mariner (as it were by a Messenger sent from Heaven) is taught which way to direct his Ship, yea as it were accompanied with a guide towards his desired Port.

For the *Needle* touched, besides other strange properties hath this, to point out in all quarters of the World, the North and South parts of the *Horizon*, and so having a Card thereto fitted with Rumbes and Degrees, it sheweth all Points of the Compasse, and degrees of the Horizon.

Yet very seldome exactly of it selfe without some further Art and industry of him that useth it; for though in some Places it swarves not yet in most parts of the World, the North and South points of the Needle, have some *variation* from the true North and South Points of the Horizon to the Eastwards or to the Westwards, which how to discover in kind and quantity, wee have shewed here-to-fore.

It may be thought, (and some men otherwise learned before this Property was fully discovered, have said) that this should be some blemish and imperfection in a Stone so precious: But it is so farre from being an imperfection, that it makes it so much the more precious. Yet (as I have said) not without the Industry of him that useth it. Hee that is negligent or unskilfull to observe it, especially in long Voyages and various Courses, may be led into many dangers by it, because hee frames not his mind to the Rule but the Rule to his mind, imagining it to be what it is not, and

and hence I ſuppoſe, ſprang that Cuſtome of placing the *Needle* or *Wyars* a Point or halfe a point to the Eaſtwards of the Northpoint of the Card, thinking by this meanes to ſhun the labour of obſerving the Variation, which indeed they might if the Variation were the ſame in all Places and at all Times, but becauſe it is not, this doth often increaſe the Errour.

But hee that diligently obſerves the Variation, finds (as I ſay) no prejudice in it, only it requires daily, or once in two or three dayes halfe an houres worke, and this labour it doth abundantly recompence; for by this meanes he knowes at the preſent how to direct his Courſe, and for the future, by thoſe notes which hee keepes of the *Variations* and *Latitudes* by him obſerved, hee knowes (comming that way againe) when hee drawes neere to any of thoſe places where ſuch Obſervations were made, and ſo falls the more certainly with any place intended.

There is further diſcovered of late, a motion or alteration in the Variation of the *Needle*, and this is ſcarce yet certainly diſcovered. But comparing the Variations which were obſerved about fifty yeares paſt, with the preſent Variations: It appeares they are leſſer *Eaſterly* and more *Weſterly* by 6 or 7 Degrees, then they were at that time. For whereas the Variation hath formerly been obſerved neare *London* to be 11 $\frac{1}{2}$ Degrees to the Eaſtwards, it doth now ſcarce exceed 4 Degrees. And there is the like alteration (as I have heard by ſome Mariners) in other parts of the World; which we now leave to the further diſcovery of Time and induſtry, and come to ſhew how to rectifie a Courſe by the Variation knowne.

The Point of the Compaſſe upon which you Sayle, and the Variation of the Needle knowne, to find the Rumbe or Degree upon which the Ship hath made her Way.

IT is beſt that the *Needle* or *Wyars* bee placed directly under the *Flower-deluce*, or *North* and *South* Points of the *Card*, and ſo in the Rules following wee preſuppoſe them to be. Now then it is to be underſtood, that the *Needle* having Variation

(as for the moſt part it hath) the Ship doth not make her way upon that Rumbe or Point of the Compaſſe which ſhe ſeemes to ſayle upon, but either more to the right hand or to the left, according as the Variation is towards the right hand, or towards the left, and that ſo much towards the one ſide or towards the other as that Variation is: We ſpeake not here of *Leeward-way*, but of the *Variation* onely. Therefore for the ſolution of this *Problem*, you muſt know how much the *Variation* is, and which way; and how this may be done, we have briefly ſhewed upon the 12 Caſe of *Right-angled Spherical Triangles*, and the 11 of *Oblique*: which knowne, you may find the Angle of the Rumbe or Line of your Ships way with the *Meridian*: being the thing in this *Problem* required.

A Table of the Angles of every Point and halfe Point of the Compaſſe with the Meridian.

	North.	South.	D. M	North.	South.
			00 00		
½			05 37		
1	N by E.	S by W.	11 15	N by W.	S by E.
1½			16 52		
2	N N E.	S S W.	22 30	N N W.	S S E.
2½			28 07		
3	NE by N	S W by S	33 45	NW by N	S E by S.
3½			39 22		
4	N E.	S W.	45 00	N W.	S E.
4½			50 37		
5	NE by E	SW by W	56 15	Nw by W	S E by E.
5½			61 52		
6	E N E.	W S W.	67 30	W N W.	E S E.
6½			73 07		
7	E by N.	W by S.	78 45	W by N.	E by S.
7½			84 22		
8	East.	West.	90 00	West.	East.
	Adde East variat. Subtract West.			Adde West variat. Subtract East.	

For

For the effecting whereof, wee will ſet downe two wayes; the one by the Pen alone, the other Inſtrumentally. If you doe it by Pen alone, although it be not hard to find what Angle every point or halfe point makes with the Meridian; yet for your further eaſe herein, I have expreſſed the ſame in the Table before-going, the quarters of Points I have omitted, becauſe the Steerage upon a quarter of a point is very uncertaine, (the points being undivided as uſually they are) for a man by his eye is able to gueſſe very nearely which is the middle betweene two points, but he cannot gueſſe ſo nearely which is the fourth part. Yet if you deſire any quarter, you may adde to the next before-going almoſt 3 Degrees, namely 2 degrees 49 minutes.

Now then by the Magneticall Rumbe or Point of the Compaſſe and Variation given: to find the true Rumbe, you are to obſerve theſe two Rules following.

1. *If the Rumbe and the Variation be both the ſame way from the Meridian (namely both to the right hand, or both to the left) adde them together, and that ſumme is the true Rumbe from that part of the Meridian.*

Yet if that ſumme exceed 90 degrees, ſubtract it from 180 degrees, the remainer is the Rumbe, from the oppoſite part of the Meridian.

2 *If the one be towards the right hand, the other towards the left ſubtract the variation from the Rumbe, and the remayner is the true rumbe.*

Yet if the rumbe be the ſmaller number, ſubtract it from the Variation, and the remayner is the true rumbe the other way.

Theſe Rules we ſhall endeavour to illuſtrate by examples following.

But firſt for diſtinctions ſake, we ſay the rumbes or degrees from the North towards the Eaſt, are towards the right hand and ſo from the South towards the Weſt; but from the North to the Weſtwards, on the left hand, and ſo from the South Eaſtwards: For a mans face being towards the North the Eaſt is on his right hand, and the Weſt on his left: &c.

In like ſort for the *variation of the Compaſſe*, if it have Eaſterly *variation*; that is, if the *Needle* and *Flower-deluce* of the *Card*

ſtand to the Eaſtwards of the North, we ſay that *Variation* is towards the right hand, for not onely the North point but all other Points of the *Compaſſe* direct a Courſe more towards the right hand then they would doe, if there were no *Variation*. And ſo if it have Weſterly *variation*; that is, if the *Needle* and *Flower-deluce* ſtand to the Weſtwards of the true North-point of the *Horizon*, wee ſay that *variation* is towards the left hand; foraſmuch as not onely the North-point, but all the other Points of the Compaſſe, ſtand more towards the left hand then they would doe, if there were no *Variation*, this being premiſed we come to give *Examples* of the two Rules before-going.

1. Let the Magneticall Rumbe or Point of the *Compaſſe* bee North-eaſt, and the *Variation* 10 degrees to the Eaſtwards: I demand the true *Rumbe*.

Here the *Rumbe* and *Variation* are both one wayes; that is, both towards the right hand; therefore,

To the Magneticall Rumbe being N Eaſterly,	45 deg. 00 m.
Adde the Variation Eaſterly ——	10 deg. 00 m.
The ſumme is the true Rumbe N Eaſterly,	55 deg. 00 m.

2. Admit a Ship ſayle upon the North-point of the Compaſſe, and that the Variation bee 10 deg. to the Eaſtwards: how doth ſhe make her way.

The Magneticall Rumbe is North, that is,	00 deg. 00 m.
To which adding the Eaſterly Variation, —	10 deg 00 m.
The ſumme is the Angle from the North-part of the Meridian to the Eaſtwards —— ——	10 deg. 00 m.

Which is almoſt *N* by *Eaſt*, and ſo hath the Ship made her way.

3. Let the Point of the Compaſſe be Eaſt ½ point Northerly, that is from the North to the Eaſtwards 7 ½ points which is 84 deg. 22 min. and the Variation as before 10 deg. to the Eaſtwards: I demand the true Rumbe?

To the Magneticall Rumbe being North-eaſt,	84 deg. 22 m.
Adde the Eaſterly Variation, ——	10 deg. 00 m.
The ſumme is the Angle from the North, ——	94 deg. 22 m.
Which ſubtracted from —— ——	108 deg. 00 m.
There reſts the true Rumbe South-eaſterly,	85 deg. 38 m.

4 *Ex-*

4 *Example.* Let the course by the Compasse be West and by South, that is 7 Points from the South to the Westwards, or 78 deg. 45 min. and let the Variation be as before 10 deg. to the Eastwards : what is the true Rumbe?

To the Magneticall Rumbe *S Westerly*, —— 78 deg. 45 m.
Adde the Easterly *Variation*, —— —— 10 deg. 00 m.
The summe is the true Rumbe *S Westerly*. — 88 deg. 45 m.

You may conceive that the *Rumbe* and *Variation* are here both one way; namely, both from the *Meridian* towards the right hand; For the Variation of the *North* point is, from the *North* towards the *East*, and consequently of the *South* point from the *South* towards the *West*, both towards the right hand of the *Meridian* as the *Rumbe* is.

5 *Example.* Let the Course by the *Compasse* be *West*, that is, from the *South* to the *Westwards* 8 Points, or 90 degrees, and let the *variation* be as before 10 deg. to the *Eastwards* : I would know the true Course or Rumbe?

To the Magneticall Rumbe *South-west*, — 90 deg. 00 m.
Adde the Variation *Easterly*, —— —— 10 deg 00 m.
The summe is the Angle with the *South*-part of the *Meridian*, —— } 100 deg. 00 m.
Which subtracted from —— 180 deg. 00 m.
There rests the true Rumbe *N West*, — 80 deg. 00 m.

Let the Course by the *Compasse* be *West*, that is, from the *North* to the *Westwards* 8 Points or 90 degrees, and let the *Variation* be 10 deg. to the *Westwards* : I demand the true *Rumbe*?

To the Magneticall Rumbe *N West*, —— 90 deg. 00 m.
Adde the Variation *Westerly*, —— —— 10 deg. 00 m.
The summe is —— —— 100 deg. 00 m.
Which subtracted from —— —— 180 deg. 00 m.
There remaines the true Rumbe *S West*, — 80 deg. 00 m.

Object. The Magneticall *Rumbe* being here West 90 deg. why should it not aswell be counted from the *South*, as frō the *North*.

Answ. It may be counted from either, for as it is counted here from the North to the Westwards it falls under the first *Rule*, because

becauſe the *Variation* is the ſame way: But if it bee reckoned from the South to the Weſtwards, it falls under the ſecond *Rule*, whereof we now come to give ſome *Examples*, ſuppoſing theſe already given ſufficient to illuſtrate the firſt Rule.

7 *Example.* Let the Point of the *Compaſſe* be *N N W*, and the *Variation* 10 deg. Eaſterly: I demand the true *Rumbe.*

From the Magneticall Rumbe *N W*: — 22 deg. 30 m
Subtract the Eaſterly *Variation* — 10 deg. 00 m.
The remainer is the true *Rumbe N W*: — 12 deg. 30 m.

8 *Example.* Let the Point of the *Compaſſe* be North, and the *Variation* Eaſterly 10 deg. What is the true Rumbe.

From the Eaſterly *Variation* — 10 deg. 00 m.
Subtract the magneticall Rumbe *N W*: — 00 deg. 00 m.
The remainer is the true Rumbe, the other way, namely *N E*: — 10 deg. 00 m.

Object. The Magneticall Rumbe may as well be named North Eaſterly, 00 deg. 00 min.

Anſw. It may, but then it is ſubject to the firſt Rule, as in the ſecond *Example*.

9 *Example.* Let the Courſe by the *Compaſſe* be Weſt, that is, from the North to the Weſtwards 8 Points or 90 degrees, and let the Variation be as before 10 degrees to the Eaſtwards: what is the true Rumbe?

From the magneticall Rumbe *N W*: — 90 deg. 00 m.
Subtract the Eaſterly *Variation*, — 10 deg. 00 m.
There reſts the true Rumbe *N W*: — 80 deg. 00 m.

Here the magneticall Rumbe might aſwell have beene South Weſterly 90 degrees, and ſo it had fallen under the firſt Rule, as in the fift *Example.*

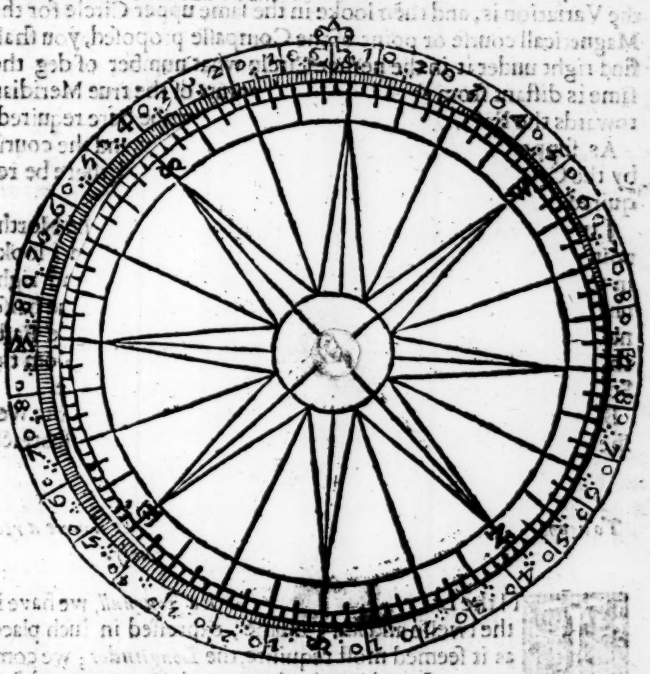
10 *Example.* Let the courſe by the Compaſſe be Weſt; that is, from the South to the Weſtwards 8 Points or 90 degrees, and let the Variation be 10 deg. to the Weſtwards: I demand the true Rumbe?

From the magneticall Rumbe *S W*: — 90 deg. 00 m.
Subtract the Weſterly *Variation* — 10 deg. 00 m.
The remainer is the true Rumbe *S W*: — 80 deg. 00 m.

If

If the Rumbe here had beene reckoned from the North as in the sixt *Example*, it had fallen under the first *Rule*.

And this may suffice for the illustration of the two former Rules, in the solution of this *Probleme*.



The same may also more easily be resolved, by such an *Instrument* as is heere described, consisting of two *Circles*, the one being the nethermost devided into foure Quadrants, and every of those into 90 Degr. numbred from the *North* and *South* points towards the *East* and *West*.

The other being the uppermost and moveable about the Center devided, as the *Card* of the Compasse into XXXII *Points*, and those againe Sub-devided into *halfes*, or *quarters*.

By

By this you may readily find the true Rumbe for any Course and Variation given.

For if you turne the *North* point of the upper Circle, from the *North* point of the lower, so many degr. and the same way that the Variation is, and then looke in the same upper Circle for the Magneticall course or point of the Compasse proposed, you shall find right under it in the nether Circle what number of deg. the same is distant from the N. or South points of the true Meridian towards the East or W. which is the true Rumbe here required.

As, suppose the Variation to be 10 deg. Easterly, and the course by the Compasse East halfe a point Northerly, and there be required the true Rumbe?

I turne the North-point of the upper Circle from the North-point of the lower 10 deg. to the Eastwards; and then I looke in the upper Circle, for East halfe a point Northerly, and right under it in the nether Circle I find 85 deg. and about one halfe, numbred from the South part of the Meridian towards the East; therefore I conclude that the true *Rumbe* required, is from the South towards the East 85½ degrees and something more.

By this *Instrument* also (if you use the Pen onely, as before wee shewed) you shall readily see when to add, and when to subtract.

CHAP. XI.

To keepe a reckoning of your Longitude, and so to set downe a reckoning by Longitude and Latitude onely.

IN the Example before given of a *Journall*, we have in the twelfe and last Colume, expressed in such places as it seemed most requisite, the *Longitudes*; we come now to shew how the same may be knowne and first;

By the Rumbe, and Latitudes given: to find the Difference of Longitude.

As *Radius* is in Proportion, To the *Tangent* of the *Rumbe*:
So is the Difference of *Latitude* in *Meridionall* parts,
To the Difference of *Longitude* in Minutes.

As let the Rumbe be North-easterly 48 deg. and suppose a Ship to runne upon this Rumbe, from the Latitude of 32 deg. 25 min.

min. into the Latitude of 34 deg. 24 min. there is required the difference of Longitude. Heere

The Meridionall parts answering to —	34 deg.	24 m.	2200
The Meridionall parts for —	32	25	2058
The Difference of Latitude in such parts, is			142.

Say then, As *Radius* is in Proportion

To the Tangent of the Rumbe to	48 deg. 00 m.	10,0456
So difference of Latitude in Meridionall parts	142	2,1523
To the difference of Longitude in Minutes	158	2,1979.

These Minutes converted into degrees, are 2 deg. 38 min. which is the difference of Longitude required, as the same is expressed in the Journall against the 21 of *February*.

And thus sayling upon one and the same Rumbe, you may find the difference of Longitude, and so often as you alter your Rumb so often working by the same Rule, you shall have all the Differences from Place to place, which added together, make the whole difference of Longitude.

But you may also find the difference of Longitude neare enough at one operation for many severall Rumbes and distances; provided that those Rumbes differ not much nor one from another. As in the former Journall from the 27 of *February* till the second of *March*, I sayle by severall Rumbes and distances from the Latitude of 43 deg. 55 min. into the Latitude of 48 deg. If you would find the difference of Longitude hereto answerable, at one operation, it may be done by this Rule:

As the difference of Longitude in Miles,
Is to the departure from the Meridian in miles;
So is the difference of Latitude in Meridionall parts,
To the difference of Longitude in Minutes.

As in that Example, the difference of Latitude for all those Courses, as in the North colume appeares, is 2444.
The departure from the Meridian, as there in the East colume appeares, is 6302.

The Merid. parts for the Latitude of	43 deg. 55 min. are	2939
The Merid. parts for the Latitude of	48 deg. 00 min. are	3292
The difference of Latitude in Meridionall parts, is		353.

Say then, As the difference of Latitude	2444	co: ar:	6,6119
To the departure from the Meridian,	6301	—	3,7994
So the difference of Latitude in Merid. parts,		353	2,5478
To the difference of Longitude in Minutes,		910	2,9591.

Which reduced into degrees, is 15 deg. 10 min. And added to the former Longitude 21 deg. 28 min.

Gives the present Longitude 36 deg. 38 m. for the 2. of *March*.

The like may be done for the account from the second of *March* to the fift of the same &c.

But if your Courses and Distances runne, be all neere to one and the same Parallel or Latitude (as in this Journall they are from the 5 of *March* to the 8, and from the 8 to the 10) then it is sufficient to find what Longitude in that Parallel is answerable to the miles of Easting or Westing, or departure from the Meridian by this Rule.

As the sine Complement of the Latitude of that Parallel,
Is in proportion to *Radius*;
So is the number of Miles in that Parallel,
To the difference of Longitude in Minutes.

As from the 5 of *March* to the 8, the Latitude was neere 50 deg. the Easterly distance 186 $\frac{1}{2}$ Miles; Therefore for the difference of Longitude, say;

As Sine complement the Latitude	s c 50 deg.	00 m.	,1919
To *Radius*,			
So is the departure from the Meridian,	186	8	3,2714
To the difference of Longitude	290	6	3,4633.

Thus it appeares the difference of Longitude is almost 291 minutes, which is 4 deg. 51 min. and this added to the Longitude upon the 5 of *March*, namely to 46 deg. 52 min. the Summe is 51 deg. 43 min. the Longitude upon the 8 of *March*, the like might be done for the 10 of *March*.

And though this last Rule be then fittest to be used when your Course is neare East and West, or your difference of Latitude little: yet it may also be used at other times in stead of the two former, without any great Errour, if you take the middle degree of Latitude, or somewhat more: as in the former Example.

The

The Latitude upon the 27 of *February*, is 43 deg. 55 min.
The Latitude upon the second of *March*, is 48 deg. 00 min.
The middle Latitude or somewhat more, is 46 deg. 10 min.

Say then. As Sine complem. the Latitude 46 d. 10 m. 1595
To *Radius*,
So the Easting or departure fro the Meridian 650. 1. 3,7994
To the difference of Longitude, 909. 7. 3,9589.

Which is almost 910 min. or 15 deg. 10 min. as before.

And thus you may in the 12. th and last Columne of your Journall, set downe your Longitude so often as you thinke is requisite; and so in the two last Columes you shall have the substance and principall scope of your Reckoning, namely your Latitudes and Longitudes, which whensoever you desire to set downe in *Mercators Chart* or in the *Polar Chart*, or in any other graduated with degrees of Longitude and Latitude you may readily doe it.

As if I would set downe the summe of the foresaid *Journall* from the 19 of *February*, to the 10 of *March*: I find against the 10 of *March* the Latitude to be 49 deg. 54 min. and the difference of Longitude 54 deg. 53 min. Therefore in the Latitude of 49 deg. 54 min. I draw an occult Parallel, and reckoning from *Summers-Ilands* towards the East 54 deg. 53 min. I draw by that Longitude an occult Meridian, the intersection of this Meridian with the foresaid Parallel is the Traverse point, or the Point representing the place of the Ship, and the like is to be understood of any other.

This forme of keeping and expressing a Reckoning, is, as I conceive, most apt and agreeable (of all others that I have seene or thought upon) to all sort of *Charts* or *Maps*, and to the *Globe* it selfe, and to all the kinds or wayes of Sayling, that are or may be used. Wee will heere adde some other Propositions which may sometimes be of good and necessary use in it.

The Rumbe and Difference of Latitude given: To find by the Table, the distance in the Rumbe, and the Departure from the Meridian thereto answerable, &c.

HOw to find the Northing or Southing, that is, the Distance in Latitude, as also the Easting or Westing, that is the Di-

in Longitude or departure from the Meridian of any Rumbe, for any distance runne upon it, we have before shewed, the like operation is in these Propositions following, namely:

2. *The Rumbe and Distance in Latitude given: To find the distance in the Rumbe, and the Easting or Westing.*

3. *The Distance and Difference in Latitude given: To find the departure from the Meridian, and the Rumbe.*

4. *The Difference in Latitude, and departure from the Meridian given: To find the Course and Distance.*

5. *The course and Departure from the Meridian given: To find the difference of Latitude and distance.*

6. *The Distance and departure from the Meridian given: to find the Course and difference of Latitude.*

So that with the first before-handled, heere are six Propositions, and in every of them two things required, and so they become Twelve. We will not stand to give Examples of them all, but onely of those which are most usefull, the rest may by them be conceived.

And first to find the Easting and Westing of any *Rumbe* for any difference of Latitude.

Admit a Ship runne North-easterly 60 deg. (that is, *N E* by *E*, and almost halfe a point Easterly) till she have altered the Latitude 40 min. how much is she departed from the Meridian?

I runne downe the Colume under 60 deg. till I find 42 Miles, or 420 tenths, and against it in the adjacent colume, I find 728 tenths, that is almost 73 Miles, which is the departure from the Meridian to the Eastwards.

If you would also have the Distance upon the *Rumbe*, it is right against these numbers in the colume of *Distances*, being in this Example 84 miles.

2. *Example.* But admit she runne North-easterly 60 deg. till she alter her Latitude 1 deg. 32'. What is the Easterly distance?

This 1 deg. 32 min. is 92 Miles or 920 tenths, for which if I looke in the colume under 60 deg. I find no number so great, but the greatest number there, is 500, which subtracted from 920, there remaines 420; therefore in that Colume under 60 deg.

100	500	866
84	420	728
184	920	1594

I looke for theſe two numbers, namely 500 and 420, and againſt the firſt in the adjacent colume I find 866, and againſt the ſecond 728, which I ſet againſt them as above appeareth, and ſo adding them, I find for this difference of Latitude, the departure from the Meridian to be 159 1/2 Miles.

If further you deſire the Diſtance runne upon this Rumbe, you have it in the colume of Diſtances, right againſt the ſame numbers, as in the Example above appeareth, where being added it amounts to 184 Miles.

The Diſtance and Difference in Latitude given: To find the Rumbe and departure from the Meridian.

ADmit a Ship runne upon ſome Rumbe, betweene the North and the Eaſt 84 miles, and then have altered her Latitude 42 min. the queſtion is, upon what Rumbe hath ſhe runne, and how many miles is ſhe to the Eaſtward in Longitude?

I runne croſſe the Table towards the right hand, looking in every firſt colume of Diſtances for 84, till I find againſt it in one of the adjacent columes 420, at the top of which colume over 420, there is 60 deg. ſhewing the Rumbe to be North Eaſterly 60 deg. alſo againſt 420 in the adjacent colume I find 788, which ſheweth the Diſtance to the Eaſtwards to be almoſt 73 Miles.

2. *Example.* But if the Diſtance runne be 184 miles, and the Difference of Latitude 1 deg. 32 min. and there be required the Rumbe and diſtance to the Eaſtwards?

Becauſe the colume of Diſtances extends but to 100 Miles, and the diſtance here given is 184 miles, you may take the halfe thereof, which is 92 miles, and likewiſe the halfe of 1 deg. 32 min. which is 46 miles, or 460 tenths; and then looke as before where you find 460 againſt 92; for there in the top of the colume you ſhall find the Rumbe, which in this Example is 60 deg. ſhewing that the Rumbe is from the North-Eaſterly 60 deg. and in the adjacent colume againſt 92 and 460, you ſhall find 797, which doubled (becauſe it is for the halfe) is 1594, ſhewing that the departure from the Meridian to the Eaſtwards, is 159 1/2 Miles. Theſe and the reſt may alſo be performed by the *Doctrine of Plaine triangles*, as we have formerly ſhewed.

CHAP.

CHAP. XII.

Certaine Problemes touching Currents.

Although the time bee already expired which I assigned for this Worke, and mine owne more urgent occasions call me away: yet seeing it is necessary in Navigations to take notice of Currents, and to make a competent allowance for them: I will briefly set downe certain *Probemes*, such as I have sometimes thought upon, whereby a man may the better conceive and judge of that allowance, the rather for that I know not any that hath handled it.

First then it is to be conceived, that a Ship or other Vessell sayling or rowing where there is a Current, hath a compound motion arising of two different Principles, namely of the current and Ships way, so that heere are three Motions to be considered; namely, two simple, and the third compounded of them. The first simple motion is that of the Current, whereby it moveth and is apt to move other things that are in it the same way: The second of the Ship or Boat as it moveth by wind or oares, or is apt to be moved, if there were no current: The third, compounded of them, is the lyne of the Ships true motion. The first we call, the way or motion of the Current: The second, the way or simple motion of the Ship: The third, her Compound or true way. The two simple motions being either of them according to right lynes and uniforme: (as in the *Problemes* following, we suppose them be) The third also, which is compoted of them is a right lyne: For whether the Ship sayle directly opposite against the Current, or directly with it the same way, or whether the one crosse the other at right Angles or at oblique: yet still either motion being direct and uniforme, they both together beget a right lyned uniforme motion, because the one retaineth to the other, one and the same proportion in every Point: And according to these grounds we proceed in the Problems following, to determine the proportions of every of these Motions, and the Angles which they make one with another.

1. *Ad-*

1. *Admit a Current runne East 3 miles an houre, and that a Ship under ſayle runne West directly againſt it 6 miles an houre in her ſimple motion; What is her true or compound Motion?*

From the Ships ſimple motion 6 miles,
Subtract the Current 3 miles,
The remainer is the Ships true motion 3 miles.

So the Ships true way is to the Weſtwards 3 miles an houre.

2. *Admit a Current runne West 6 miles an houre, and that a Ship under ſayle runne directly againſt it, 5 miles an houre by the Logge: What is the Ships compound motion, and which way?*

From the Current being the greater 6 miles,
Subtract the Ships ſimple motion 5 miles,
There remaines the Ships true motion 1 mile.

Which 1 Mile ſhewes that the Ship by her compound motion falls a ſterne, that is, moves to the Weſtwards 1 mile an houre.

In the Experimentall practiſe of the two former *Problemes*, it may ſeeme that a Ship or Boat ſo ordered, hath alſo a motion to the right hand or to the left, but this comes to paſſe, becauſe it is hard, and in a manner impoſſible to ſteame a Tide or ſtreame ſo exactly, but that the Ship will ſwarve (or Yaw as they ſay) either to the one ſide or to the other.

3. *Admit a Current runne East 3 miles an houre, and that the Ship alſo runne East 3 miles an houre by the Logge: What is the Ships true motion?*

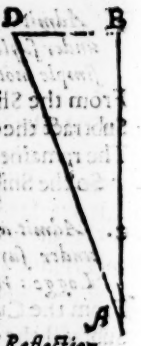
To the Ships ſimple motion 3 miles, Adde the Current 3 miles,
The ſumme is the Ships true motion 6 miles.

So the Ships compound or true way is East 6 miles an houre.

4. *Admit a Current runne East two miles an houre, and the Ship South 6 miles an houre; What is the Ships true motion, and which way?*

In handling of any Art, to avoyd circumlocution there are uſed termes or words of Art, ſerving to expreſſe briefly the things handled. And forasmuch as this ſubject hath not beene formerly handled, nor the Principles or Grounds thereof layd (ſo farre as I know) we will adde a few ſuch termes as may ſeeme moſt neceſſary, expreſſing here what we meane by them.

Let the lyne A B run from A to the Southwards, and B D from B to the Eastwards, and let A B be in proportion to B D, as 6 to 2, or 3 to 1.



Then doth A B represent the lyne of the Ships simple motion, B D the motion of the Current, and A D the compound motion of the Ship.

And D A B is the Angle contained betweene the lyne of the Ships simple motion, and the lyne of her compound or true motion, which for brevities sake we will henceforth call *the Angle of Deflection.*

Also A D B is the angle contained betweene the lyne of the Ships compound motion, and the sett or drift of the Current which we will call *the Angle of Reflection.*

Lastly, A B D is the angle contained betweene the lyne of the Ships simple motion, and the sett of the Current, which wee will call *the Angle of Incidence.*

Then for the Rumbe, the Proportion is thus:

As the simple motion	A B 6 miles,	*co: ar:*	9,2219
Is to the Current	B D 2 miles,		0,3011
So is *Radius*			
To the tangent of Deflection	ꝺ D A B 18 deg. 26 min.		9,5230.

So the Rumbe upon which the Ship makes her way good is South 18 deg. 26 min. Easterly; that is, *S S East*, 4 deg. 4 min. Southerly.

2 *For the Ships true way, or Compound motion,*

As the sine of the deflection	s D A B 18 deg. 26 min.		0,5000
To the Current	D B 2 miles,		0,3011
So *Radius*			
To the true motion	A D 6, $\frac{3}{4}$		0,8011.

So the Ships compound motion is 6, $\frac{3}{4}$ miles hourely, that is 6 $\frac{1}{3}$ miles almost.

5. *A Ship sayles West five dayes together by the Log 725 miles, but there is a Current, all this while setting to the Southwards 1 $\frac{1}{2}$ mile an houre; I demand how she hath sayled, and how farre?*

The Current setting 1 $\frac{1}{2}$ mile an houre, setts in five dayes 180 miles; Therefore,

A

As the ſimple motion	A B	725 miles,	7,1397
Is to the Current	D B	180 miles,	2,2553
So is Radius			
To the tangent of Deflection,	t D A B	13 deg. 57 min.	9,3950.

For the Diſtance,

As ſine Compl. the deflection,	s c D A B	13 deg. 57 min.	0,0130
Is to the ſimple motion	A B	725 min.	2,8603
So is Radius			
To the compound motion	A D	747.	2,8703.

So the Ships true way is, Weſt Southerly 13 deg. 57 min. or South-weſterly 76 deg. 03 min. 747 Miles.

6. *A Ship ſayles Weſt five dayes together by the Logge 725 miles, in a Current ſetting to the Southwards, and then finds that hee hath altered his Latitude 3 degrees; I demand the motion of the Current, the true Rumbe and true way of the Ship?*

This Queſtion differeth little from the former, for ſeeing the difference of Latitude is 3 deg. The motion of the Current is 180 Miles: So there is given the Ships ſimple motion, and the motion of the Current, as before, &c.

7. *A Ship in 6 houres ſayles from a certaine* Cape *or Head-land, South 30 miles by the Logge, in a Current ſetting Eaſterly, and then obſerving the ſame Cape, hee finds that it beares N N W; I demand how faſt that Current ſetts, and how farre hee hath ſayled?*

As let a Ship ſayle from A towards B, South 30 miles, but by meanes of the Current, ſhe is driven more Eaſterly; namely to D, from whence ſetting the Cape A, it is found to beare N N W. And ſeeing the Current ſetts from B towards D Eaſterly; therefore the angle of Reflection B D A is 6 Points, that is 67 deg. 30 min. Here then is demanded the diſtance A D, and the drift of the Current in that time B D.

As the ſine of the angle of Reflection,	s B D A	67 d. 30 m.	,0344
To the ſimple motion of the Ship	A B,	30 miles,	1,4771
So the ſine of the angle of Deflection	s D A B,	22 d. 30 m.	9,5736
To the motion of the Current	B D,	12,5.	1,0581.

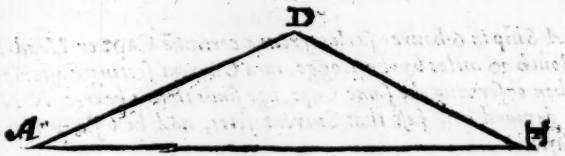
And further,

As the Sine of the angle of Reflection s B DA, 67 d. 30 m. .9344
To the distance run by the Logge A B, 30 miles, 1,4771
So is Radius
To the compound motion of the Ship A D, 32 1/2 1,5115.

And thus we find that Current to set 12 1/2 ; that is, neare 12 1/2 Miles in 6 houres, and the Distance runne to be 32 1/2 miles almost.

That the thing may be better conceived, wee will use two or three Examples more familiar and obvious to every mans experience: yet grounded upon the same Principles and Reasons.

8. *Admit that* Tulis-staires *beare from* Billingsgate-staires *S W Southerly; namely South-westerly 40 degrees, and be distant 80 Poles: and suppose the Tide of ebbe to runne there Eastwards 2 1/2 miles an houre, and that a paire of Oares, rowing 4 1/2 miles an houre, would goe straight over from the first to the second: how shall they row over, namely upon what Degree or Point of the Compasse, and how farre shall they row to get thither, and in what time?*



Let A represent *Billingsgate-staires*, D *Tulis-staires*, A E the simple motion of the Boate, E D the motion of the Current: Then is A the angle of Deflection; E the angle of Incidence; D the angle of Reflection 130 deg. or 50 degrees.

As the simple motion of the boate A E 4 1/2 miles, 9,34679
Is to the motion of the Tide D E 2 1/2 miles, 0,39794
So the sine of Reflection D s 50 deg. 9,88425
To the sine of Deflection A s 23 deg. 3 m. 9,62898.

Thus then the Position from A to D being South-westerly 40 deg.

deg. and the angle of deflection A, 23 deg. 03 min. the position from A towards E is South-westerly 63 deg. 03 min. that is, W S W, Southerly. And so must those Oares row to goe straight over.

Secondly for the Distance A E.

From the angle of Reflection	D, 50 deg. 00 min.	
Subtract the angle of Deflection	A, 23 deg 03 min.	
And there rests the angle of Incidence	E, 26 deg. 57 min.	
As the sine of Incidence	s E, 26 deg. 57 min.	0,34370
To the true Distance	A D, 80 Poles	1,90309
So the sine of Reflection	s D, 50 deg. 00 min.	9,88425
To the simple motion	A E, 135 $\frac{1}{10}$ poles.	2,13104.

Lastly, for the Time, seeing 320 Poles make a Mile, and they row 4 $\frac{1}{2}$ miles in an houre, it is 1440 Poles in an houre: So the Proportion is,

As the simple hourely motion	1440	6,8416
To the simple motion before found	135 $\frac{1}{10}$	2,1310
So is an houre in Minutes, namely	60 min.	1,7781
To the time required in minutes.	5 $\frac{43}{100}$	0,7507.

And so long will they be rowing over.

9. *But suppose they will Row harder, to goe a shorter cut; namely to goe S W by West, how fast must they row to goe straight over, and how farre, and in what time?*

Then seeing the Position from A to D, is South-westerly 40 deg. and S W by W, is South-westerly 56 deg. 15 min. Therefore the angle of Deflection at A is 16 deg. 15 min. the angle of Reflection D, as before, 50 deg. 00 m. the angle of Incidence E, is 33 deg. 45 min.

As the sine of deflection	s A, 16 deg. 15 min,	9,55311
To the motion of the Tide	D E, 2 $\frac{1}{2}$ miles	0,39794
So the sine of the angle of reflection	D, 50 deg. 00 m.	9,88425
To the simple hourely motion of the boat	A E, 6 $\frac{144}{1000}$	0,83530.

And such is the hourely motion of the Boate, namely 6 $\frac{144}{1000}$ Miles in an houre.

Secondly, for the simple Motion.

As the sine of Incidence	s E	33 deg. 45 min.	,25526
Is to the true Distance	A D	80 Poles	1,90309
So the sine of Reflection	D	50 deg. 00 m.	9,88425
To the simple motion	A E	110 1/2 poles	2,04260.

Thus it appeares they must row 110 1/2 Poles to get over.

Lastly, for the Time.

The hourely motion before-found 6 1/4 reduced into Poles, is 2190 1/2.

As the simple hourely motion		2190	6,65956
Is in proportion to an houre or		60 min.	1,77815
So is the simple motion before-found		110 1/2	2,04260
To the Time required	—	3 1/4 min.	0,48031.

And so long will they be rowing over.

10. *But admit a Sculler rowing three miles an houre, would crosse straight over at the same time, upon what Point must hee row, and how farre to get thither, and in what time will hee doe it?*

First, *for the Angle of Position.*

As the hourely motion of the boate	A E	3 miles	9,52288
To the sine of Reflection	D s	50 deg.	9,88425
So is the hourely motion of the streame	D E	2 1/2 m.	0,39794
To the sine of deflection —	A s	39 d. 40'.	9,80507.

Now seeing the Position for *Billinſgate* to *Tuli*-ſtaires, namely from A to D, is by ſuppoſition to the Weſtwards of the South 40 deg. and the angle of Deflection A is here found to be 39 d. 40 min. Therefore the poſition from A to F, is from the South to the Weſtwards 79 deg. 40 min, which is Weſt and by South, and almoſt 1 deg. Weſterly, and ſo muſt that Sculler row to goe ſtraight over.

Secondly, for the Diſtance A E.

From the angle of Reflection	—	D	50 deg. 00 min.
Subtracting the angle of Deflection		A	39 deg. 40 min.
There remaines the angle of Incidence		E	10 deg. 20 min.
As the sine of Incidence	s E	10 deg. 20 min.	,74624
To the true Diſtance	A D	80 Poles	1,90309
So is the sine of reflection	s D	50 deg. 00 min.	9,88425
To the simple motion	A E	341 1/2 poles	2,53358.

And

And thus it appeares, that though the Distance of the two places bee but 80 Poles, yet if according to the question, hee row but after three Miles an houre, and the streame sett after 2½ Miles an houre, then he must row 341 $\frac{6}{10}$ Poles to goe straight over.

Lastly, for the Time.

Three miles is 960 Poles, say then

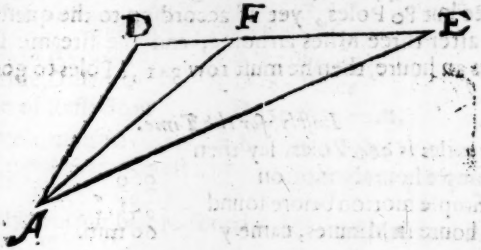
As the simple hourely motion	960	7,01773
To the simple motion before found	341 $\frac{6}{10}$	2,53358
So is an houre in Minutes, namely	60 min.	1,77815
To the time required in minutes	21 $\frac{35}{100}$	1,32946.

And thus it appeares that the time requisite to row over, rowing 3 Miles an houre, is 21 $\frac{35}{100}$ Minutes, whereas wee found before, that rowing there 4½ miles an houre, they might row over in 5 $\frac{43}{100}$ Minutes, which is little more than a fourth part of the time.

There might be other and that great variety of Questions of this nature proposed and resolved, many of good use in practise, which the Watermen by daily experience without other Rules, are able to guesse at something nearely, sufficing for their occasions: my intent in these is especially to explicate the Compound motion of a Ship, or other Vessell sayling or rowing where there is a Current; which by such familiar Examples may seeme more evident. I cannot insist upon them by reason of mine other occasions, nor spend that time in these here handled, which else I should have done; whence if any defect or mistake should arise, if the Reader be pleased to give me friendly notice of it, I shall as thankfully accept it, and reforme it: We propose next a question at Sea, which let be this.

11. *There is a Current at Sea setting East 12 miles in 24 houres, a Ship sayles in the same from a certaine Port. West South-west 6 dayes, and then returning thence, and sayling N E by North 3 dayes, falls with the Port from whence hee first departed; I demand what his dead Reckoning was outwards and what backe againe, and how farre these two Ports were asunder, and upon what Point of the Compasse?*

As



As let the Current set from E towards D, and let the first Port be A, the second F, and let the Course outward bound be represented by A E, and the Course homewards by D A &c.

And forasmuch as D E is an East and West lyne, and A E West S W; therefore the angle at E is 22 deg. 30 min. and by the like reason, the angle at D is 123 deg 45 min. or 56 deg. 15 minutes, and the angle at A 33 deg. 45 min. and E D being the setting of the Current for 9 dayes, is 108 Miles.

First then for the dead Reckoning outwards, namely A E.

As the sine of the angle at	A s,	33 deg. 45 min.	,25526
To the lyne ——	D E,	108 miles	2,03342
So is the sine of the angle	D s,	58 deg. 15 min.	9,91985
To the lyne ——	A E,	161 ,5	2,20833.

Thus A E his dead Reckoning outwards, is 161 ,5.

Secondly, for A D.

As the lyne of the angle	D A E s	33 deg. 45 m.	,25526
Is to the lyne ——	D E	108 miles	2,03342
So is the sine of the angle	D E A s	22 deg. 30 m.	9,58284
To the lyne ——	A D	74 ,5 miles	1,87152.

Which 74 ,5 miles is his dead Reckoning homewards.

Thirdly,

Thirdly, for the angle D A F, *or* D F A.

The side A D is found	74. $\frac{1}{2}$ Miles.	
The side D F for 3 dayes, is	36 miles.	
The summe of both, is	110. $\frac{1}{2}$	
Their difference is	36. $\frac{1}{2}$	
The summe of the angles D A F and D F A,	56 deg. 15 min.	
The halfe summe is	—— ——	28 deg. 07 m. $\frac{1}{2}$

The Proportion.

As the summe of the sides	110. $\frac{1}{2}$	7,95703
Is to their difference	38. $\frac{1}{2}$	1,58433
So is the Tangent of	28 deg. 07 m. $\frac{1}{2}$	9,72796
To the tangent of ——	10 deg. 32 min.	9,26932.

Which added together, make the angle D F A, 38 deg. 39 min. and a halfe.

And seeing the rumbe from F to D is East, and the angle D F A 38 deg. 39 min. and a halfe; therefore the Rumbe from F to A, is to the Northwards of the East 38 deg. 39 min. and a halfe, that is N E by East almost halfe a point Northerly, which is the Rumbe from the second Port to the first.

Lastly, for A F *the Distance of these two Ports.*

As the sine of the angle	D F A, 38 deg. 39'. $\frac{1}{2}$	,20434
To the dead Reckoning homewards	A D 74. $\frac{1}{2}$ miles	1,87152
So is the sine of the angle	D s 56 deg. 15 min.	9,91985
To the Distance ——	A F 99. $\frac{11}{100}$ miles	1,99571.

Thus the true Distance of those two Ports is 99 Miles and somewhat more.

Sundry other *Questions* of like nature might be proposed, which to him that well understandeth these will not be difficult.

These Principles a little enlarged may further with a few Experiments, bee applyed in the discovery of some mysteries in Compound motions not yet divulged; though much endeavoured by sundry famous men in severall parts of *Europe*; but these wee shall not touch at present.

12. *To find where there is a Current at Sea; also which way it Setts, and how fast.*

THis may be done by comparing the Reckoning outwards, with the reckoning homewards, whereof wee will give an Example or two.

First admit a Ship sayle from a certaine Port, by one or severall Rumbes or Distances, till shee arrive at a second, and there find reckoning by Course and Distance, that she is more Southerly than the Port from which she departed, by 541 Miles, and more Westerly by 145 miles: But by his reckoning homewards, when he arrives againe at the first place, he finds himselfe to the Northwards of the second 541 miles as before, and to the Eastwards 305 miles. Now supposing hee were three dayes outwards bound, J would know which way the Current setts, and how fast? Here because the Easterly distance homewards is greater then the Westerly distance outwards; therefore from the Easterly distance 305 miles, subtract the Westerly distance 145 miles, the remainer being 160 miles, is the motion of the Current to the Westwards.

And thus it appeares that that Current setts to the Westwards 160 miles in Eight dayes, that is 20 Miles a day, or $\frac{5}{6}$ of a mile every houre.

2. *Example.* Admit a Ship sayle from the *Summer-Ilands*, by severall Rumbes and Distances, till shee arrive at Cape *Codd* in *New-England*. Namely, from the East part of the *Summer-Ilands*, (the Variation being allowed) first North 20 miles, and then N N W 150 miles; the second day N by W 180 miles: the

	North	*South.*	*East.*	*West.*
North 20 miles	20 0			
North N W. 150 miles	138 6			57 4
North by W. 108 miles	176 5			35 1
North, 90 miles	90 0			
North-east, 88 miles	62 2		62 2	
528 Miles	487 3		62 2	92 5
				62 2
				30 3

third

third day North 90 miles, the fourth day N East 88 miles, and so arrive at Cape *Codd*. Then by these Courses and Distances we may gather by the fore-going Table, that Cape *Codd* should by this Reckoning be to the Northwards 487 miles : and to the Westwards 30 miles, as here appeares.

Now suppose she sayle backe againe from Cape *Codd* towards the *Summer-Ilands*, the first day S S W, 150 miles; the second day S S W, 160 miles; the third day S by W, 130 miles; the fourth day South, 140 miles; the fifth day East 110 miles, and so bee come againe to the East part of the Summer-Ilands.

	North	South.	East.	West.
South S W, 150 miles		138 6		57 4
South S W, 160 miles		147 8		61 3
South by W, 130 miles		127 5		25 3
South, 140 miles		140 0		
East, 110 miles.			110 0	
690 Miles		554 0	110 0	144 0
				110 0
				34 0

These Courses and Distances make as here appeareth, the Summer-Ilands to bee to the Southwards of Cape *Codd* 554 Miles, and to the Westwards 30 miles.

Therefore by this last Reckoning backe againe Cape *Codd* should be to the Northwards of the Summer-Ilands 554 miles, and to the Eastwards 34 miles, whereas by the former Reckoning outwards, it was to the Northwards onely 487 Miles, and to the Westwards 30 miles; so that the Difference of these two reckonings outward and backe againe, is 67 miles Northerly, and 64 miles Easterly, which sheweth that the Current in that time, namely in 9 Dayes, hath sett to the Northwards 67 miles, and to the Eastwards 64 miles; that is, North-east a little Northerly 93 miles, as by the fore-going Table doth appeare, which is 10⅓ Miles every day.

And what wee have here done by the Tables, might have beene done (as the fore-going Problemes) by the Doctrine of plaine Triangles.

FINIS.

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